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10 BIG SPACE CONSPIRACIES SILENCED BY SCIENCE

#246 NOVEMBER 2025

Sky at Night

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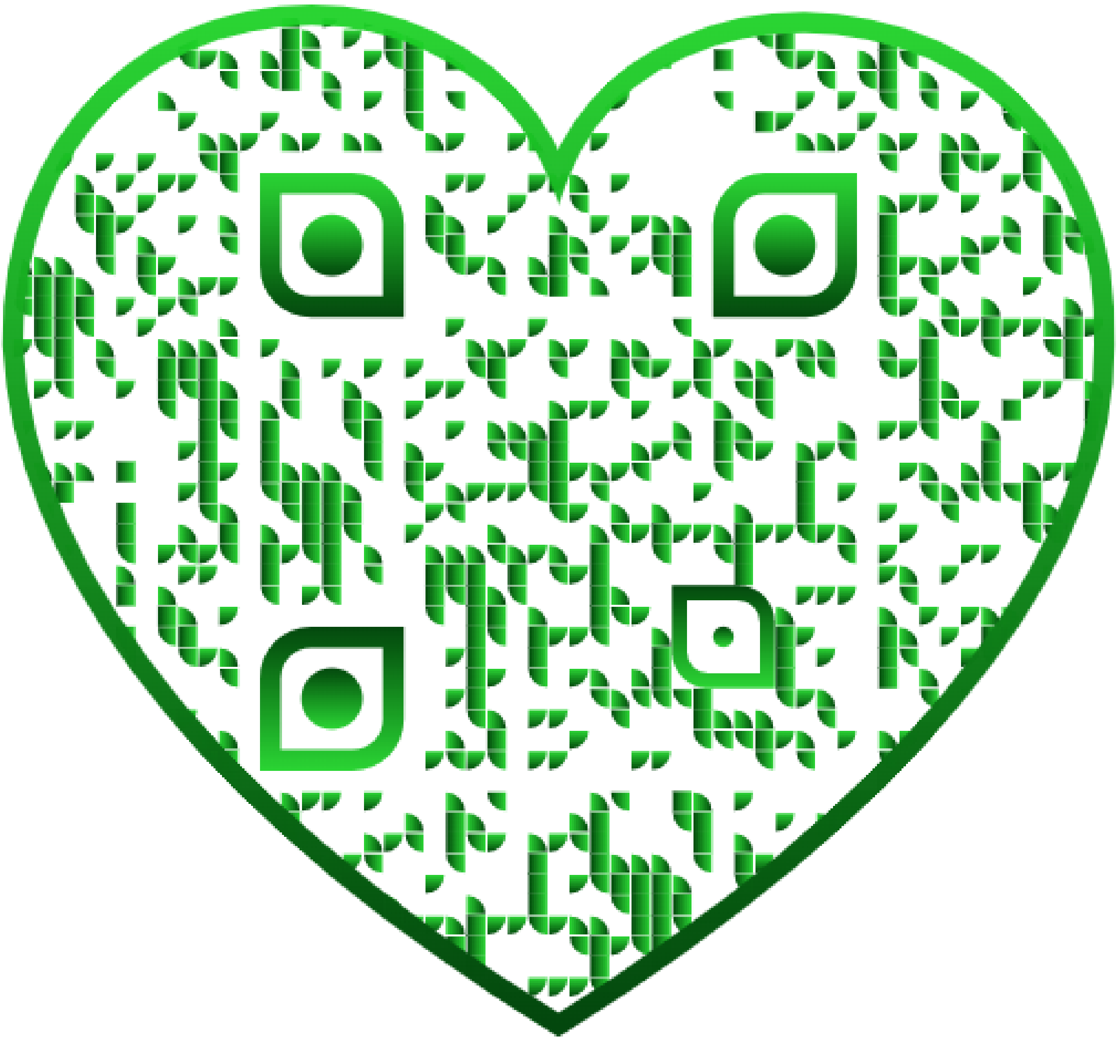

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Welcome

This month: comets, crackpot theories and cosmic curveballs

We've been spoiled for comets lately. Not only is interstellar visitor 3I/ATLAS on its way through the Solar System from an entirely different part of the Galaxy, but comet A6/LEMMON also caused a stir after it showed signs of brightening through October. This month, there are two more comets to add to the list, with E1 Wierzchoś and 24P/Schaumasse both swinging through our corner of the Solar System. You'll find more details, including the timing of 24P's brush with the lovely Beehive Cluster, in the Sky Guide from **page 43**.

Predictably, comet 3I/ATLAS's appearance came with unfounded claims that it was an alien spacecraft. Astronomers who know about these icy bodies were quick to point out that, while its path is exceptional, its behaviour is entirely as expected. Still, leaping to extraordinary conclusions seems to be hard-wired into our culture. On **page 67**, Alastair Gunn looks at 10 of the most persistent conspiracy theories about space – and why they don't stand up to scientific scrutiny.

One area where science is raising knotty questions is cosmology, as you'll find in our feature on **page 60**. Here, Colin Stuart explores how observations of the far-distant Universe are throwing one of cosmology's longest-standing principles into question. So central is this theory, the results could force us to rethink everything we thought we knew about the cosmos.

Enjoy the issue!

Chris Bramley, Editor

PS Our next issue goes on sale on Tuesday 18 November.

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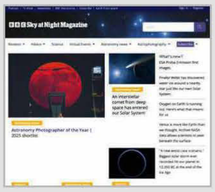
Sky at Night – lots of ways to enjoy the night sky...

Television

Find out what *The Sky at Night* team have been exploring in recent and past episodes on page 18



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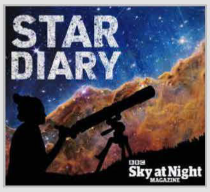

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COVER IMAGE: CLOSE-UP OF A COMET © GERALD RHEMANN AND MICHAEL JÄGER | THIS PAGE: UNISTELLAR | GETTY X 3, NASA, JPL | @THESHED_PHOTOSTUDIO | EDUARD MUZHEVSKYI, ALAMY | NASA | MARK GARLICK, SCIENCE PHOTO LIBRARY, ALAMY | UNIVERSITY OF ST ANDREWS X 2 | ALARIC WEBSTER

New to astronomy?

To get started, check out our guides and glossary at **www.skyatnightmagazine.com/astronomy-for-beginners**

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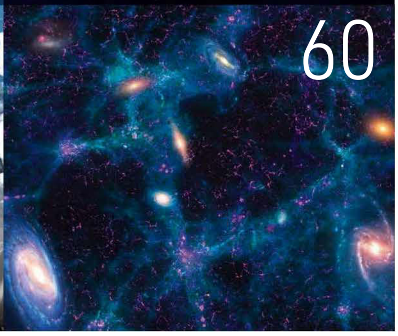
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This month's contributors

Govert Schilling

Astronomy author

"The discovery of extra-terrestrial intelligence would be a turning point in the history of science." **Govert looks at the scientists scanning for 'technosignatures' – evidence of alien technology, page 28**

Colin Stuart

Astronomy writer

"I love it when something doesn't play by the rules. It's often the first clue that helps unravel a mystery." **What if the Universe isn't uniform? Colin examines the huge implications on page 60**

Dani Robertson

Dark skies expert

"One thing I'm always asked is 'how dark is a dark sky?'. I'll show you how the Bortle scale can give you a quick answer to that all-important question before you travel to a stargazing destination." **Join Dani on page 72**

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NOVEMBER HIGHLIGHTS

Can a planet have a planet?

Belinda Damian discusses the giant, free-floating worlds that may form their own planetary systems.

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The Messier catalogue

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Our extended gallery, featuring the best astro images sent to us by *BBC Sky at Night Magazine* readers.

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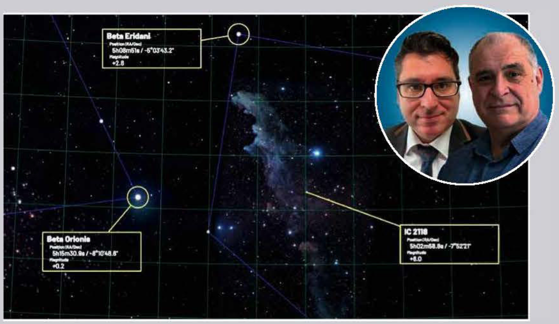
The Virtual Planetarium



Pete Lawrence and Paul Abel guide us through the best sights to see in the night sky this month.

WAITING IN THE WINGS

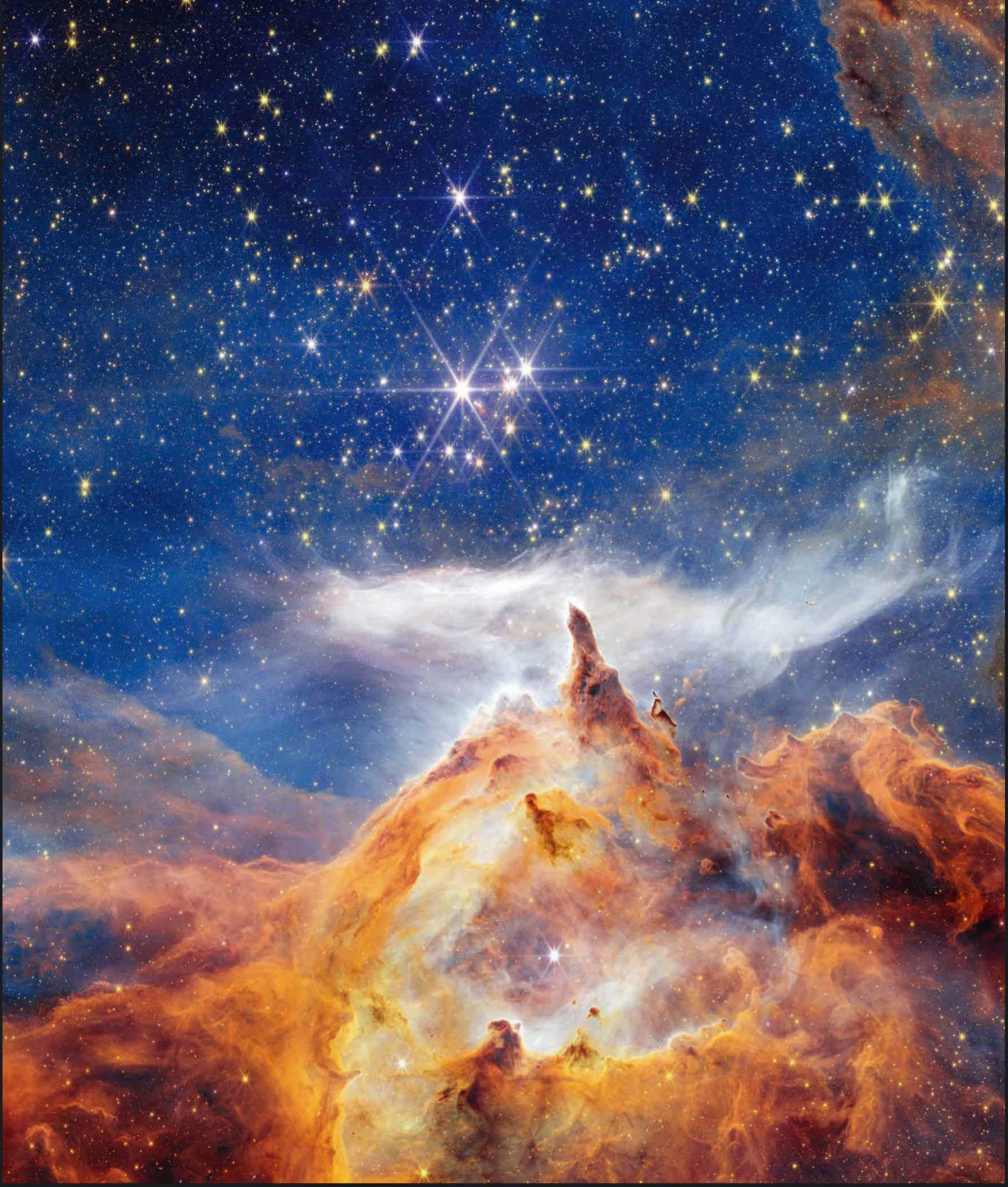
This butterfly star cloaked in dust is preparing to hatch some planets

JAMES WEBB SPACE TELESCOPE AND HUBBLE SPACE TELESCOPE, 29 AUGUST 2025

The reddish, vertical bar in this image is the protoplanetary disc around a newborn star some 525 lightyears from Earth. Officially named (somewhat inelegantly) IRAS 04302+2247, this infant star is already being orbited by a disc of gas and dust that within just a few millennia may clump together and form planets.

We're seeing this disc from edge-on, which is why it looks more like a bar in this picture. This also means the disc is blocking light from the star itself, enabling the faint glow of two reflection nebulae on either side to become visible. With its wing-like glow, it's easy to see why it's been nicknamed the Butterfly Star.

ESA, WEBB, NASA & CSA, M. VILLENAVE ET AL



◁ Pointing the finger

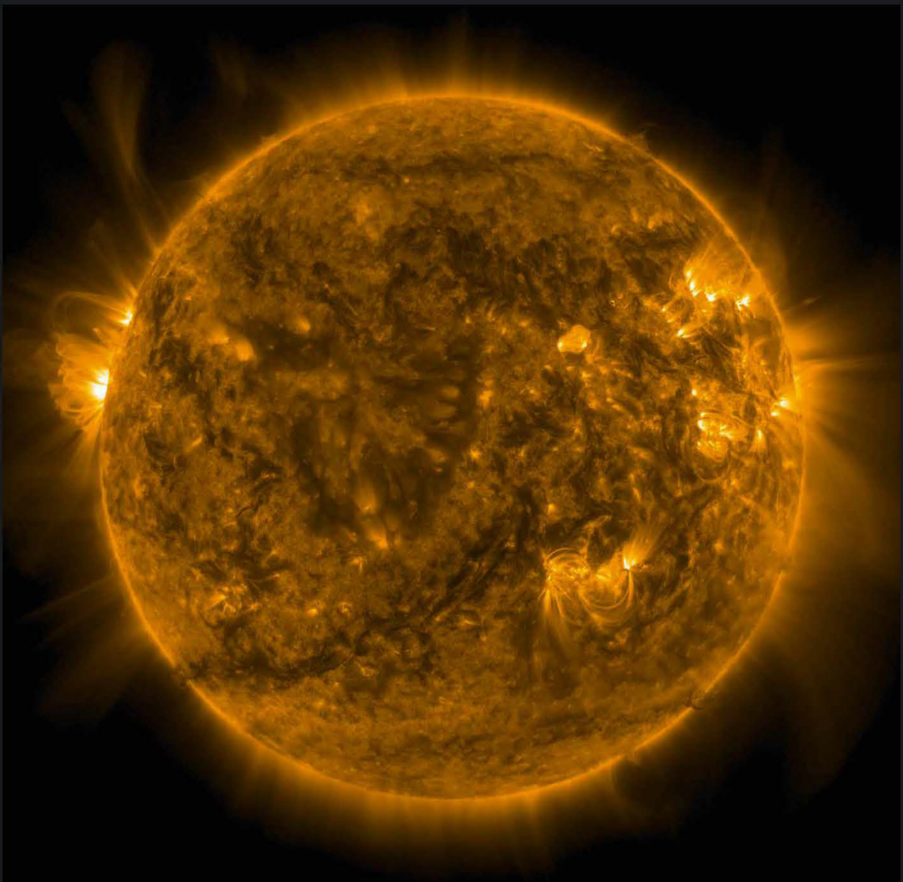
JAMES WEBB SPACE TELESCOPE, 4 SEPTEMBER 2025

This is Pismis 24, a region of star formation within the Lobster Nebula, with Pismis 24-1 – the cluster's brightest, largest star – sitting just left of centre in the image. A 'finger' of the nebula's gas and dust appears to point straight at it – and to give you an idea of scale, the narrow tip of that finger is around 200 times wider than our entire Solar System.

Busy body ▷

SOLAR DYNAMICS OBSERVATORY, 10 SEPTEMBER 2025

This image of the Sun was captured recently by NASA's Solar Dynamics Observatory, as part of a study confirming that solar activity has been steadily increasing since 2008, reversing a four-decade decline. The causes of this surge in activity have yet to be determined.



NASA, ESA, CSA, STSCI; IMAGE PROCESSING: A. PAGAN (STSCI) | NASA, GSFC, SOLAR DYNAMICS OBSERVATORY

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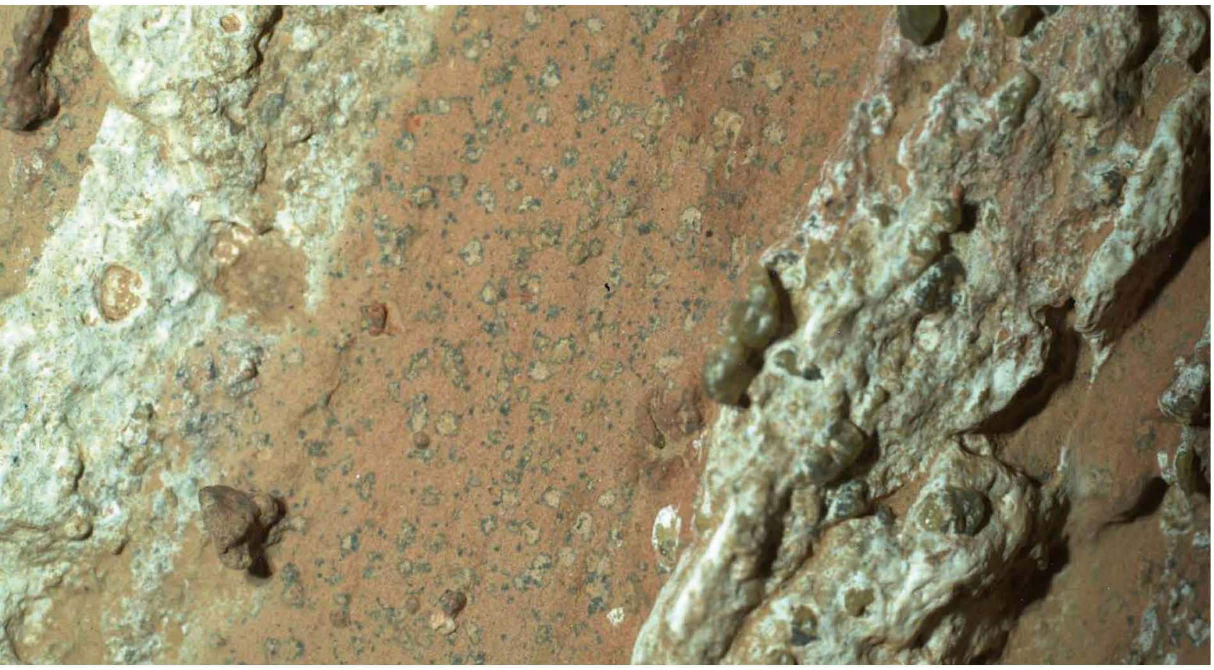
The latest astronomy and space news, written by Jamie Middleton

BULLETIN



▲ Iron-rich minerals in Mars's 'leopard spot' rocks mirror those left by microbes on Earth

NASA, JPL-CALTECH, MSSS | NASA, KIM SHIFLETT | ESO, A. LEVAN, A. MARTIN-CARRILLO ET AL

NASA finds new evidence for life on Mars

Biosignatures of potential ancient microbial life found in dry riverbed

We've had a few false alarms before – including fossilised microbes and signs of carbon dioxide production in Martian rocks – but NASA has now cautiously suggested it's found signs that life once existed on Mars at the same time that it was emerging on Earth.

Since 2021, the Perseverance rover has been exploring what's thought to be a dried-up lake in Jezero Crater, a site chosen for its potential to preserve ancient life, if it ever existed on the Red Planet. In July last year, near the mouth of an ancient river, it took samples from the Bright Angel formation, rocks marked with patterns nicknamed 'leopard spots' and 'poppy seeds'.

These samples contain minerals arranged in ways that, on Earth, are found in the byproducts of microbial activity. Put simply, they're the waste products left behind as microbes consume water-rich sediments – microbe poo, in other words. Technically, the minerals are rich in the compound vivianite, surrounding small cores enriched in the mineral greigite. Vivianite is common in Earth's sediments and peat bogs, especially near decaying organic matter, while certain microbes on Earth can produce greigite.

"The combination of chemical compounds we found in the Bright Angel formation could have been a rich source of energy for microbial metabolisms," says Perseverance scientist Joel Hurowitz, lead author of the new research.

Since then, NASA has been doing everything it can to show this biosignature *isn't* from life – so it's quite exciting that it can't. The paper's authors are keen to stress that some unknown, non-biological chemistry could still be responsible. But that's the key word: unknown. The most plausible non-biological candidates are an acidic water reaction or high heat, but the surrounding rocks show no signs of either in this part of Mars.

"NASA makes this data available to the wider science community for further study to confirm or refute its biological potential," says Nicky Fox, associate administrator for science at NASA. It's likely that true confirmation will only come if Perseverance's samples are brought back to Earth, where more involved tests can be run. But this is the strongest evidence yet that life could have existed on other planets.

www.nasa.gov

Comment

by Chris Lintott

My message for anyone claiming that this is definite evidence for life on Mars: not so fast. Like the phosphine discovery on Venus, we're dealing with chemistry in an environment very different from Earth. In this case, that's the result of millions of years on the slowly evolving Red Planet – timescales that allow mineral-forming processes never important on dynamic, ever-changing Earth to play a role. So: not so fast.

What we really need is to get Perseverance's samples back, but those plans are delayed due to NASA budget woes and US politics – and solving that certainly feels like it could take billions of years. We may have the answer one day – but, not so fast.

Chris Lintott co-presents *The Sky at Night*

Artemis II's Moon-bound crew (from left): Jeremy Hansen, Victor Glover, Reid Wiseman and Christina Koch

Humans to orbit Moon again after 53 years

NASA eyes February launch date for first crewed lunar fly-by since Apollo

More than half a century since humans last visited our lunar neighbour – or indeed travelled beyond low Earth orbit – NASA has announced plans to send four astronauts around the Moon. The Artemis II mission was originally planned for April 2026, but the agency now says it could launch as early as 5 February.

The crew – Americans Reid Wiseman, Victor Glover and Christina Koch, and Canadian Jeremy Hansen – will embark on a 10-day voyage to "explore the Moon for scientific discovery, economic benefits, and to build the foundation for the first crewed missions to Mars". The flight is part of the Artemis programme, which aims to establish a sustainable human presence on the Moon.

Although the mission won't land on the lunar surface, it will take the astronauts farther into space than any human has gone before. "They're going at least 5,000 nautical miles (9,200km) past the Moon," says Artemis II flight director Jeff Radigan, "which is much higher than previous missions have gone." This is to test the latest capabilities of the Orion spacecraft, after it had issues at the launchpad and suffered heatshield damage on the first Artemis mission in November 2022.

As for when NASA will actually land on the Moon, the Artemis III mission that's scheduled to do that is planned for 2027. But with SpaceX's Starship Human Landing System falling behind schedule – and complex orbital refuelling manoeuvres still to be demonstrated – that deadline may yet slip. With China outlining plans for a crewed Moon landing in 2030, the emergence of a new lunar Space Race is becoming ever more real.

www.nasa.gov

Day-long space explosion baffles astronomers

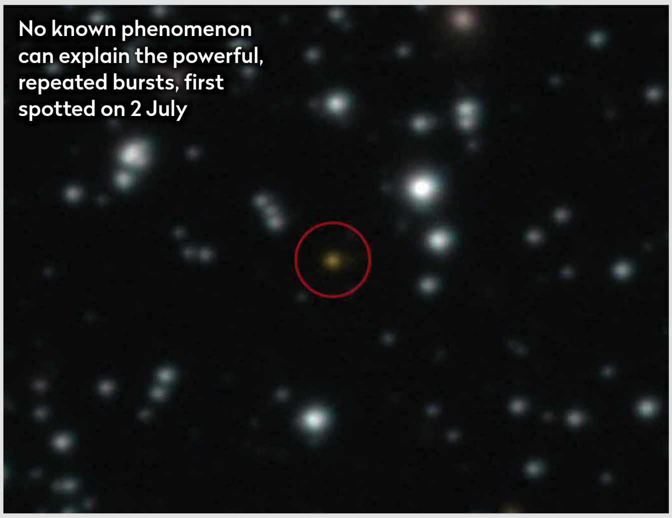
The massive gamma-ray burst lasted 1,000 times longer than any seen before

A giant gamma-ray burst (GRB) has been detected that has astronomers scratching their heads. GRBs are some of the most powerful explosions in the Universe and are thought to be produced by the catastrophic destruction of stars. But this new explosion, spotted a few billion lightyears outside our Galaxy and named GRB 250702B, was unlike any seen before, bringing this theory into question.

"This event is unlike any other seen in 50 years of GRB observations," says Antonio Martin-Carrillo of University College Dublin and co-lead author of the study. "GRBs are catastrophic events; they're expected to go off just once because the source that produced them does not survive the dramatic explosion. This event baffled us, not only because it showed repeated powerful activity, but also because it seemed to be periodic, which has never been seen before."

To add to the mystery, while most GRBs last just a few milliseconds or minutes, this one lasted a day. "This is 100 to 1,000 times longer than most GRBs," explains the study's co-author Andrew Levan.

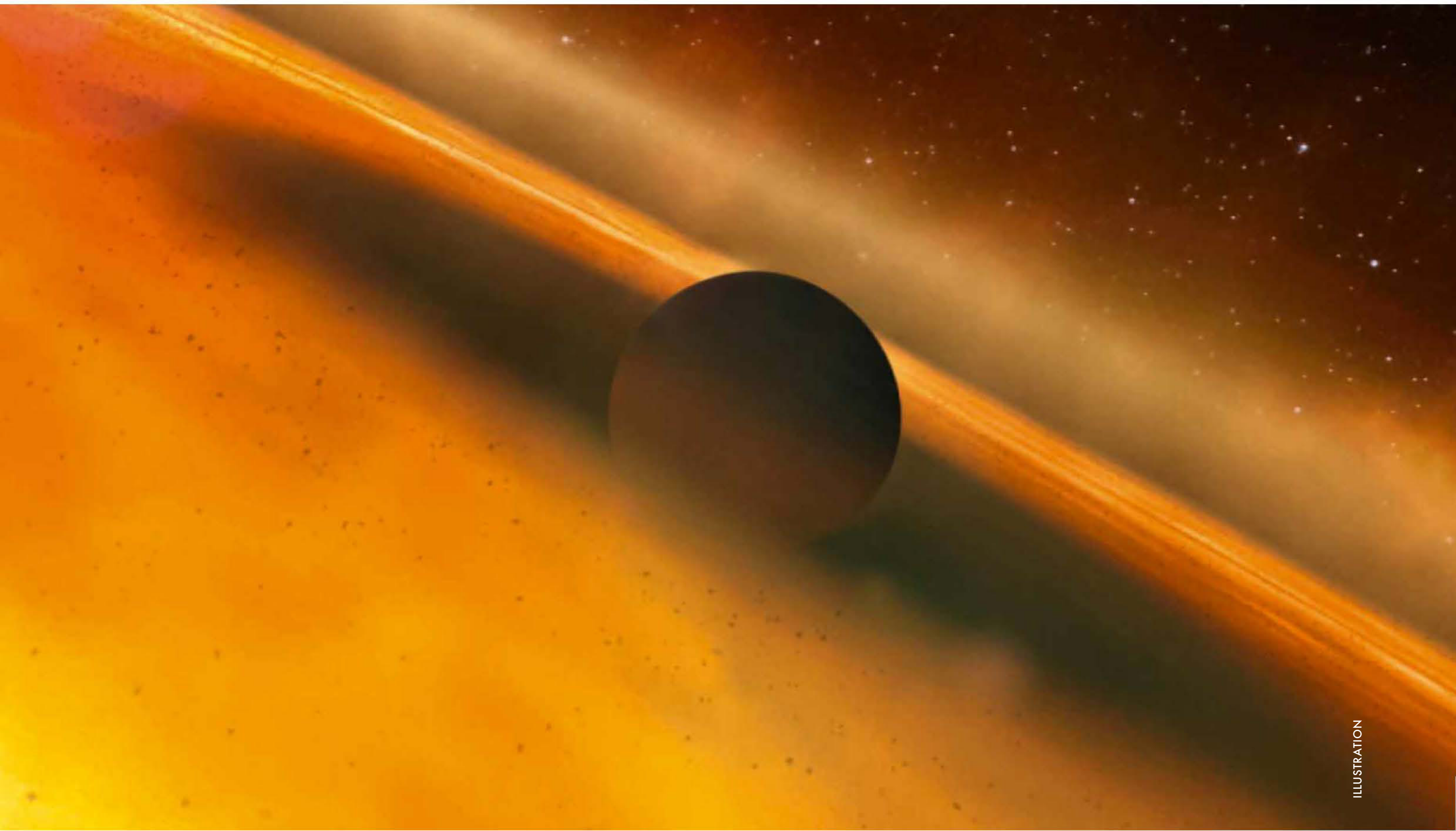
Various telescopes were trained on where the GRB was thought to originate, with ESO's Very Large Telescope placing it outside our Galaxy. The fact that it's so far away means that the explosion must have been incredibly powerful.



No known phenomenon can explain the powerful, repeated bursts, first spotted on 2 July

"We're still not sure what produced this or if we can ever really find out," says Martin-Carrillo, "but with this research, we've made a huge step towards understanding this extremely unusual object."

www.ucd.ie



▲ **No Sun required? Some roaming 'rogue' planets are circled by planet-making discs, like miniature Solar Systems**

Rogue planets host their own mini planetary systems

Starless, free-floating giant worlds may build rocky planets of their own

When we imagine planets, we usually picture them circling a fiery star like our Sun. But new evidence has now been found of a type of planetary system that instead forms around cold planets that float free through the cosmos.

Using JWST's powerful infrared instruments, astronomers at the University of St Andrews in the UK have discovered dusty discs around a selection of these 'rogue' worlds. Spectroscopic analysis revealed that the planets, each 5–10 times the mass of Jupiter, have discs with the same composition as the protoplanetary discs found around young stars, from which planets typically coalesce.

They also found silicate grains in the rogue worlds' discs that show signs of crystallisation and growth – in other words, signs that tiny asteroids, the seeds of rocky, Earth-like planets, were being created.

"These discoveries show the building blocks for forming planets can be found even around objects that are barely larger than Jupiter and drifting alone in space," says the study's lead author, Belinda Damian. "This means that the formation of planetary systems is not exclusive to stars, but might also work around lonely starless worlds."

One theory states that rogue planets are like 'failed stars' (or brown dwarfs), but much smaller. They are celestial bodies without the mass to start nuclear fusion in their cores, but still with the gravity to retain the dust orbiting around them.

An alternative view is that they are planets that began forming around a star in the way that astronomers are familiar with, but were kicked out of their system by the gravity of a passing star or another large planet.

Previous research showed that the discs that form around free-floating planets could survive for several million years – long enough for planets to form.

"Taken together, these studies show that objects with masses comparable to those of giant planets have the potential to form their own miniature planetary systems," explains Aleks Scholz, the lead investigator. "Those systems could be like the Solar System, just scaled down by a factor of 100 or more in mass and size."

However, while the potential for planets to form is clearly there, "whether such systems actually exist remains to be shown," says Scholz.

news.st-andrews.ac.uk

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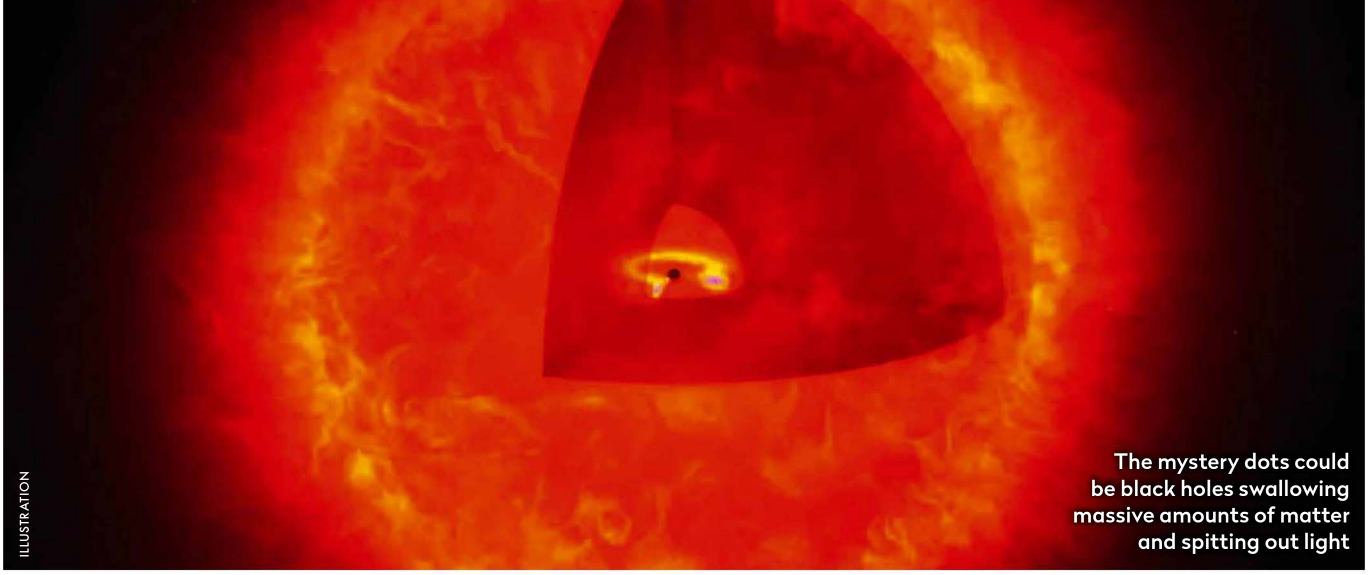


ILLUSTRATION

The mystery dots could be black holes swallowing massive amounts of matter and spitting out light

‘Universe breakers’ could be black hole stars

Unexplained little red dots may be an entirely new precursor to black holes

JWST’s discovery of ‘little red dots’ in 2022 seemed to upend what we understood about how the Universe formed. Red, compact and completely unexpected, they were thought to be an unusually early type of galaxy that formed 700 million years after the Big Bang. Dubbed ‘Universe breakers’, the red objects appeared to be either massively heavy galaxies or modestly sized ones, each with a supermassive black hole at its core. Either way, it was thought that these galaxies shouldn’t have had time to get as large and dense as they appear.

New research now suggests the Universe may not be quite as broken as we thought. It proposes that these dots may not be galaxies at all, but a new type of object called a ‘black hole star’ (or BH*). These are massive spheres of dense superheated gas that look like the atmospheres of stars. However, rather than the nuclear fusion that powers the stars we know, they are heated by supermassive black holes gorging themselves and blasting out energy.

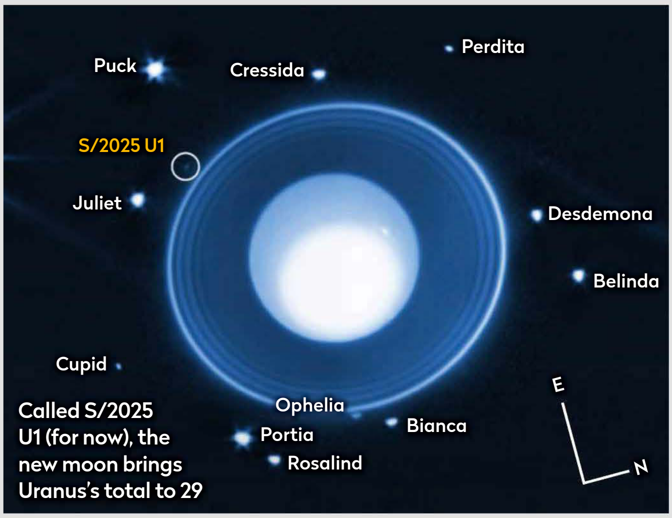
“It’s an elegant answer really,” says Joel Leja from Pennsylvania State University and co-author of the study, “because we thought it was a tiny galaxy full of many separate cold stars, but it’s actually effectively one gigantic, very cold star.”

The theory could also help answer another cosmological conundrum, as Leja explains: “No one’s ever really known why or where these gigantic black holes at the centre of galaxies come from. These ‘black hole stars’ might be the first phase of formation for the black holes that we see in galaxies today – supermassive black holes in their little infancy stage.”

www.aanda.org

JWST discovers new Moon orbiting Uranus

At just 10 kilometres wide, this is the smallest satellite yet found around the ice giant



Called S/2025 U1 (for now), the new moon brings Uranus’s total to 29

The JWST has discovered a brand-new resident of our Solar System: a tiny moon orbiting Uranus, thought to be a mere 10km (6 miles) wide. That means you could walk around it in just a few hours – provided you found a way to stick to its low-gravity surface, of course.

“It’s a small moon, but a significant discovery, which is something that even NASA’s Voyager 2 spacecraft didn’t see during its fly-by nearly 40 years ago,” says Maryame El Moutamid, who led the team that spotted it.

The moon is in good company, as its discovery brings the number of moons orbiting the planet up to a grand total of 29. “No other planet has as many small inner moons as Uranus,” says Matthew Tiscareno of the SETI Institute in California. “Their complex inter-relationships with the rings hint at a chaotic history that blurs the boundary between a ring system and a system of moons.”

This moon is thought to sit in a mostly circular orbit 56,000km (35,000 miles) above the centre of Uranus, which places it below the five larger moons Miranda, Ariel, Umbriel, Titania and Oberon.

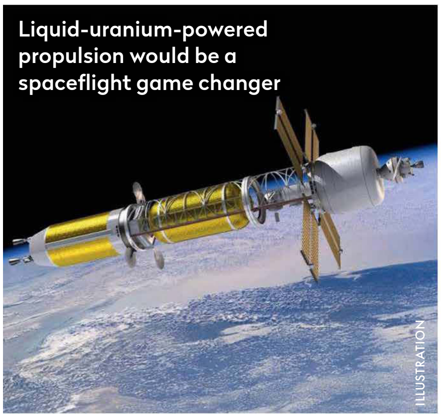
It currently has the rather uninspiring name S/2025 U1, but as all the satellites of Uranus have been named after characters from Shakespeare and Alexander Pope, this is likely to change.

Before that though, more observations are needed to confirm its characteristics. Current estimates assume the moon has the same reflectivity as the other satellites of Uranus, which may not be true.

www.science.nasa.gov

New rocket could slash Mars travel time

Nuclear propulsion and asteroid refuelling may unlock rapid deep-space travel


Liquid-uranium-powered propulsion would be a spaceflight game changer

If we want to explore the farthest reaches of our Solar System, current rocket speeds are just not up to scratch. Even with our fastest engines, it's a three-year round trip to Mars – and that's our closest neighbour.

Stepping up to the plate to tackle this problem are scientists at Ohio State University. With NASA funding, they are developing a rocket which they say can cut the time it takes to get to the Red Planet by half. The key element to achieving this? Liquid uranium.

Called the centrifugal nuclear thermal rocket (CNTR) system, instead of relying on chemical combustion or solid nuclear fuel rods to heat rocket propellant (like those used in engines tested at the beginning of the Space Race), the engine spins the uranium at very high speeds to keep it in liquid form. Propellant is then bubbled through this molten uranium, reaching a very high temperature before it is fired out of the engine nozzle. This, they say, can produce three to four times the thrust of a chemical rocket.

"You could have a safe one-way trip to Mars in six months, for example, as opposed to doing the same mission in a year," says engineering PhD Spencer Christian, who is leading the construction of the prototype.

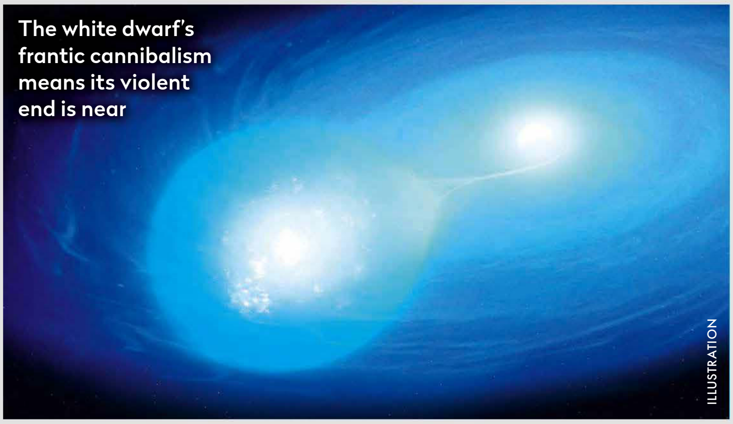
The CNTR rocket can also use a range of propellants, including those that are commonly found in space, such as ammonia, methane, hydrazine and propane. As these can be found in asteroids and other space objects, this could open up the possibility of refuelling en route, extending the rocket's range.

The system is still in the early stages of development, explains Dean Wang from the project team: "We have a very good understanding of the physics of our design, but there are still technical challenges we need to overcome. We need to keep space nuclear propulsion as a consistent priority in the future, so that the technology can have time to mature."

www.osu.edu

Forget Betelgeuse: there's a new supernova in town

V Sagittae may soon erupt in a nova that lights up the sky – even in daylight


The white dwarf's frantic cannibalism means its violent end is near

A new supernova may soon light up our skies. An international team of astronomers have been studying a greedy white dwarf in a binary star system called V Sagittae, which is just 10,000 lightyears from Earth. It's burning unusually brightly as it speedily consumes its much larger companion star. In fact, it's stripping this stellar material so fast it can't handle all of it, creating a halo of shining gas which surrounds both stars.

"V Sagittae is no ordinary star system," says Phil Charles from Southampton University, one of the study's authors. "It's the brightest of its kind and has baffled experts since it was discovered in 1902. Our study shows that this extreme brightness is down to the white dwarf sucking the life out of its companion star, using the accreted matter to turn it into a blazing inferno."

"It's a process so intense," he continues, "that it's going thermonuclear on the white dwarf's surface, shining like a beacon in the night sky."

Using observations from the ESO's Very Large Telescope, the team believe that the high speed at which the cannibal star is consuming its larger twin means it will meet a cataclysmic end very soon. The explosion – which could shine as bright as the Moon – could still be years or even decades away.

"The matter accumulating on the white dwarf is likely to produce a nova outburst in the coming years, during which V Sagittae would become visible with the naked eye," says Pablo Rodríguez-Gil, co-author of the study.

www.southampton.ac.uk

NASA, MARSHALL | MARK GARLICK, SCIENCE PHOTO LIBRARY, GETTY | NASA, JPL-CALTECH

Mysterious lumps found inside Mars

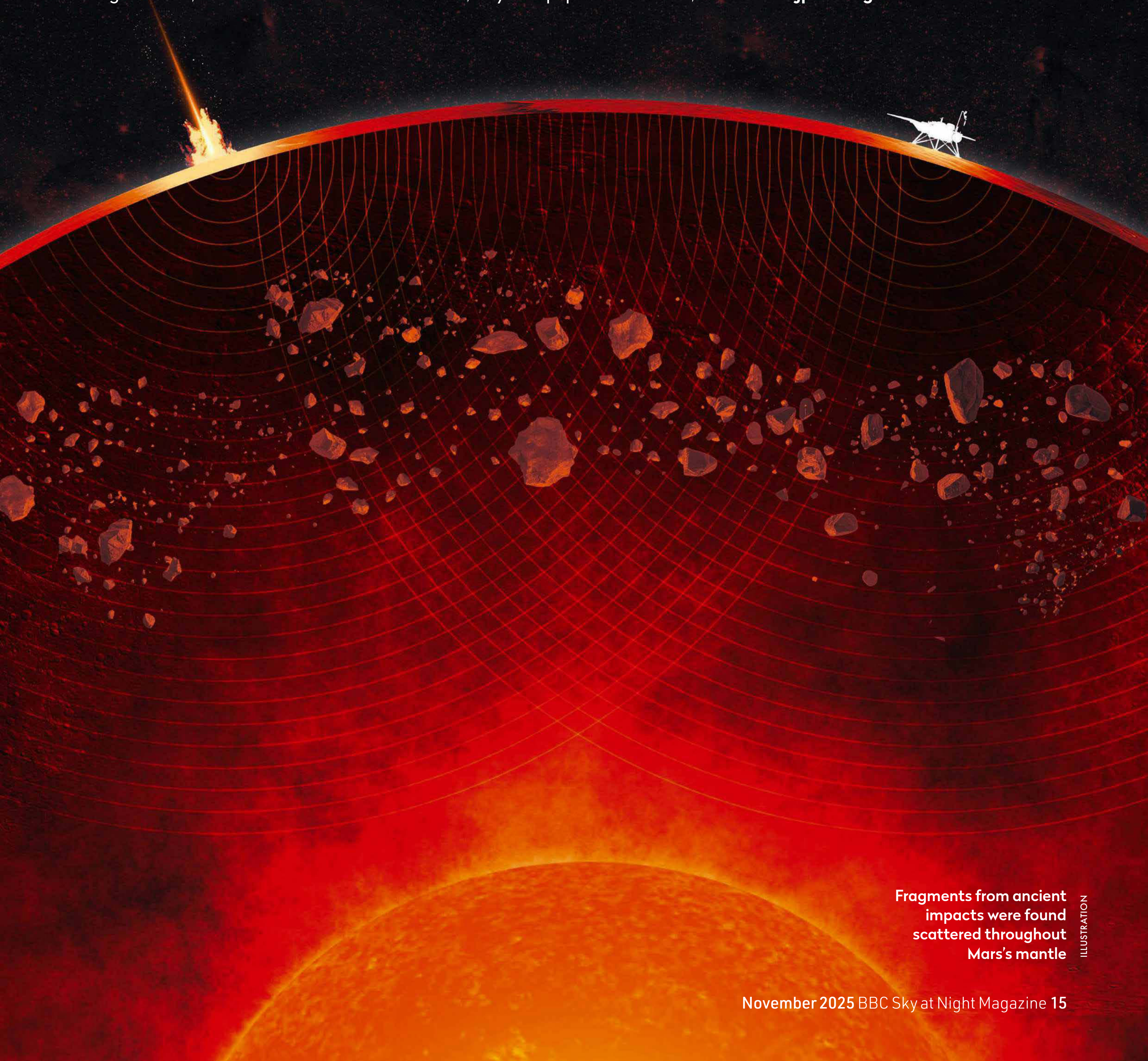
InSight Lander reveals the Red Planet's interior in amazing detail

New research has found strange, dense blobs under the surface of Mars. They are thought to be the remains of meteorites that crashed into the planet in its infancy, and they have been preserved there since the Solar System was formed.

The researchers used data from the InSight Lander, which monitored tremors beneath Mars's surface between 2018 and 2022. By studying how these marsquakes speed up and slow down as they travel through the planet, they built an 'X-ray' of its internal structure.

"We've never seen the inside of a planet in such fine detail and clarity before," says the paper's lead author, Constantinos Charalambous of Imperial College London. "What we're seeing is a mantle studded with ancient fragments. Their survival tells us Mars's mantle has evolved sluggishly over billions of years. On Earth, features like these may well have been largely erased."

www.jpl.nasa.gov

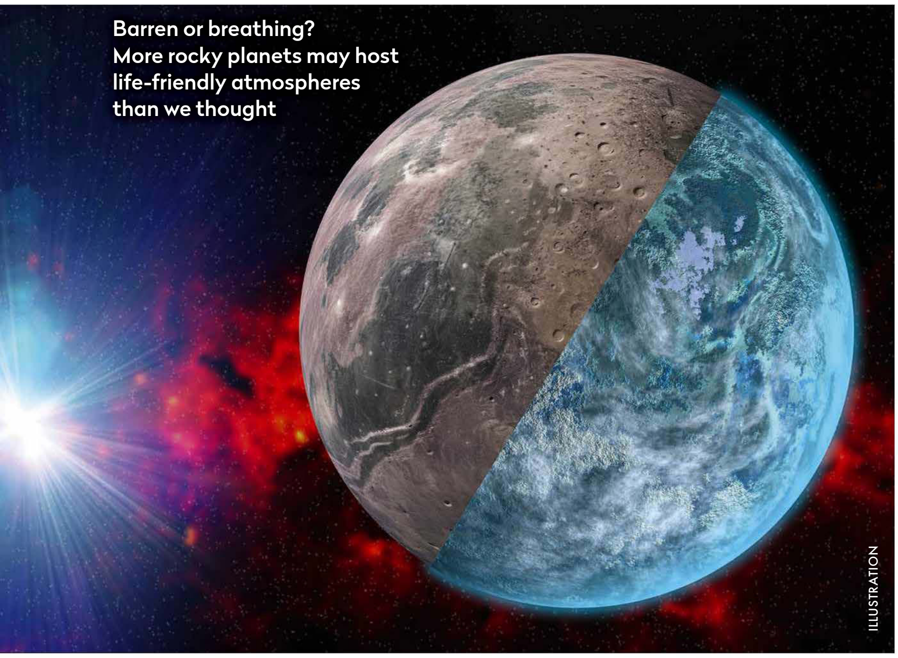


Fragments from ancient impacts were found scattered throughout Mars's mantle

ILLUSTRATION

Our experts examine the hottest new research

CUTTING EDGE



Barren or breathing? More rocky planets may host life-friendly atmospheres than we thought

Air clings to small planets after all

Small, rocky worlds once thought bare may have habitable atmospheres

One of the most important features of extrasolar planets is whether they have an atmosphere or not. For astrobiology in particular, small, rocky planets blanketed with an atmosphere offer the best hope in the search for life beyond Earth.

The two key factors affecting whether a planet can retain an atmosphere over billions of years are: its escape velocity, which affects how well its gravity is able to hold on to a gas envelope; and the cumulative amount of sunlight it has received from its star (instellation). High instellation, particularly of extreme X-rays, acts to strip away gas molecules.

In an influential 2017 paper, Kevin Zahnle and David Catling plotted known exoplanets, as well as the planets and moons in our Solar System, on axes of escape velocity versus instellation. They fitted a line on the graph to separate those worlds known to have an atmosphere from airless bodies, which they called the 'cosmic shoreline'. Worlds lying above this shoreline (that is, those with a low escape velocity relative to the strength of their sunlight) have been stripped of any existing atmosphere. This is useful, because it allows astronomers to predict which smaller exoplanets that have not yet been well characterised are expected to have an atmosphere or not. Other studies since 2017 have attempted to refine this cosmic shoreline, running computer models of atmospheric escape processes.

Now, two astronomers from the Institute of Astrophysics of the Canary Islands (IAC) on Tenerife, Pedro Meni-Gallardo and Enric Pallé, have built on this. The 'classical' cosmic shoreline calculated by Zahnle and Catling excludes exoplanets that have since been discovered to possess an atmosphere, and so the position of the demarcation line on the plot needs to be updated. Meni-Gallardo and Pallé have also taken a slightly different tack to other studies. Rather than relying on simulations, they've updated the concept using only observational data. That is, they've taken an empirical approach.

More worlds make the cut

They used all the latest results contained in the IAC ExoAtmospheres database – a repository of the 274 exoplanets for which atmospheric gases have been detected – and combined this with information on these exoplanets from the NASA Exoplanet Archive.

The gradient of the cosmic shoreline on the plot is particularly important to establish accurately, as this has a significant impact on which small (and thus low escape velocity), potentially habitable exoplanets might have been able to retain their atmosphere.

> *"They used a repository of 274 exoplanets for which atmospheric gases have been detected, combined with the NASA Exoplanet Archive"*

And so for their Empirical Cosmic Shoreline (ECS), the researchers pinned the demarcation line to pass through Mars and the super-Earth 55 Cancri e, which they argue are edge cases: planets right on the threshold of having just lost their atmosphere. The gradient of their new ECS is steeper than previous studies, and so they conclude that a lot more of the low-mass planets orbiting M-class 'red dwarf' stars – which are some of the easiest for telescopes like JWST to analyse – have in fact retained their atmospheres.

Based on their analysis, Meni-Gallardo and Pallé say that the TRAPPIST-1 planets c–e are likely bare rocks. But TOI-700 e and d, Earth-sized planets in the habitable zone of their star, are promising candidates that have been able to retain their atmospheres.

Prof Lewis Dartnell is an astrobiologist at the University of Westminster

Lewis Dartnell was reading... *An Empirical Determination of the Cosmic Shoreline* by Pedro Meni-Gallardo and Enric Pallé
Read it online at: arxiv.org/abs/2508.12865

VICTOR HABBICK VISIONS, PABLO CARLOS BUDASSI, STOCKTREK IMAGES, GETTY | TITOONZ, GETTY

Ancient poem reveals historic supernova

A medieval Arabic verse offers new clues to explosion's date and position

It's a source of some frustration that the last time we spotted a supernova in the Milky Way Galaxy – all the way back in 1604 – no one had a telescope to point at it. We have to content ourselves with studying the remnants of previous supernovae, which at least tell us how these spectacular explosions affected their surroundings.

Such observations are more valuable the more we know about the supernovae themselves. There are a few contemporary observations from Europe – Kepler spotted that 1604 event, for example – but mostly we rely on Japanese and Chinese records.

This month's paper makes a good case for Arabic observations of two historical supernovae: a bright event in 1006, which was widely seen; and a less well-known one in 1181 or 1182, which may have been hiding in plain sight. The observations are contained in a poem which the authors – Arabists and an astronomer, working together – believe they can, for the first time, reliably date.

Japanese and Chinese records suggest a northern supernova around 1181, and for a while astronomers were convinced they knew which pulsar it had produced. However, this candidate remnant is now believed to be too old. Instead, an otherwise obscure star known as IRAS 00500+6713 has been connected with the explosion. It has a surrounding nebula that seems about a millennium old, but whether this system could have survived a supernova is uncertain.

Hidden in flattery

Enter Ibn Sanā' al-Mulk, sitting in 12th-century Cairo writing a poem to praise the great leader Saladin. The poem, preserved in collections all over the world, mentions a new 'najm', or star – a term the authors point out would have included a supernova. Crucially, this new star, which in the poem appears to reflect Saladin's greatness, lies in or near the constellation of al-Kaff al-Khabīb, or the Dyed Hand – an asterism made up of the five bright stars we call Cassiopeia, which matches the supernova's northern location.

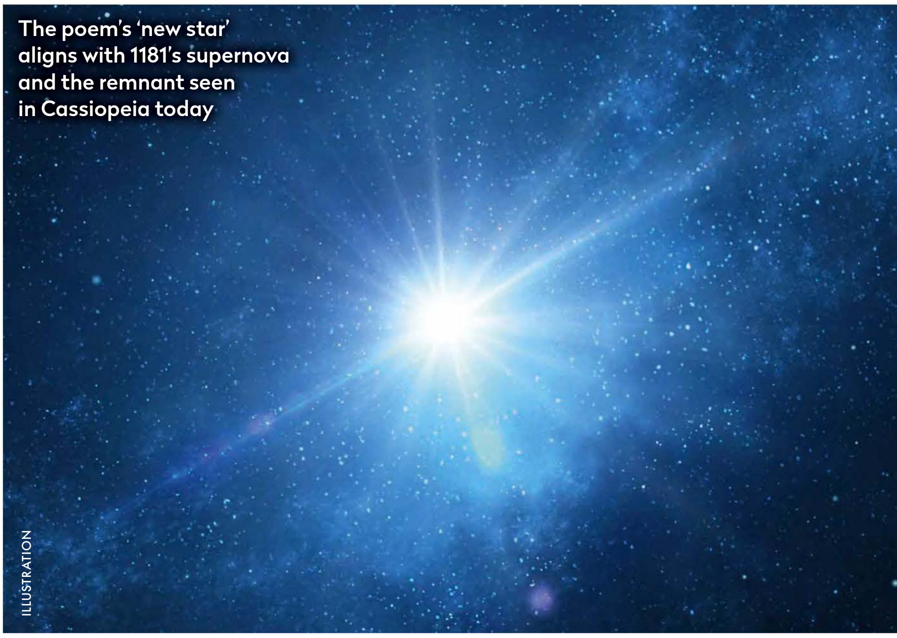
Prof Chris Lintott is an astrophysicist and co-presenter on *The Sky at Night*

> **"The poem, preserved in collections all over the world, mentions a new 'najm', or star... which matches the supernova's location"**

So there's a new star. But we need to know when the poem was written. The authors note this is a praise poem, written to impress a powerful protector. But there is praise not only for Saladin but for his brother, which only makes sense if both were in the same place to hear it: and they were both in Egypt in 1181/1182. In addition, the poem praises Saladin for defending Mecca, a feat the authors match with a Crusader attack in December 1181. The poem, then, must have been written between December 1181 and May 1182, when Saladin left Egypt. If the new star – which we're told is bright – is indeed our supernova, this gives us a pretty exact age.

That's very useful science, derived from a historical analysis of a poem that was designed to flatter and charm. But there's one more lesson to take from this story. If the research authors are correct, and Ibn Sanā' al-Mulk is using a recent supernova to praise his patrons, then knowledge of this bright new star must have been commonplace, at least among the court.

As well as scientific information, the poem gives us a glimpse of a society where a nearby supernova was big enough news to reach even the great and the good. Whenever the next supernova is spotted, let's hope we're as lucky.



The poem's 'new star' aligns with 1181's supernova and the remnant seen in Cassiopeia today

ILLUSTRATION

Chris Lintott was reading... *New Arabic Records from Cairo on Supernovae 1181 and 1006* by J G Fischer, H Halm et al.
Read it online at: arxiv.org/abs/2509.04127

Behind the scenes of *The Sky at Night* TV show

INSIDE THE SKY AT NIGHT

J. McFALL
esa

airZero G
esa
ZERO-G TEAM

Former Paralympian John McFall, pictured right during zero-G training, has been certified for long-duration spaceflights

October's *Sky at Night* episode examined what it takes to become an astronaut. But why, wonders **George Dransfield**, is the opportunity still not available to everyone?

Who hasn't watched a show like *Gladiators* or *Total Wipeout* and thought: "Yeah, I could do that"? Or even: "I bet I could do *better*"? In my case, that thought also extended to – wait for it – astronaut training. Yes, I can almost hear everyone's eyebrows collectively shooting skyward. But in those days I used to spend my time running marathons and doing triathlons (okay, one triathlon), so when I saw footage of NASA's Chosen Ones doing underwater training and zero gravity flights, I thought it looked... easy?

I say "in those days" because obviously something happened to put me firmly in my place. Early in 2018, I went to a residential teacher-training course hosted by the European Space Agency in Belgium. The goal was to equip science teachers to use space in their teaching, but there were also some activities that were just for fun, including getting to play around with kit that simulated elements of astronaut training. I'm pleased to report I was a natural at Moonwalking. However, I did poorly at riding a giant gyroscope. Imagine a Venn diagram of screaming, crying and hysterical laughing – the intersection gives you an idea of the sound I made throughout my ride.

All the while, I was also attempting to trace a grid with a crayon on a piece of paper to simulate the navigation of a capsule that was spinning out of control. I don't exaggerate when I say I felt nauseous for weeks after. So really, it was made clear that astronauting is not for me, and may best be left to those with stronger constitutions.

George Dransfield is an exoplanet huntress at the University of Oxford and a presenter on *The Sky at Night*

> *"I don't exaggerate when I say I felt nauseous for weeks after. Astronauting is not for me"*

ESA, A. CONIGLI | ESA, NOVESPACE | GEORGE DRANSFIELD | BBC

In October's episode of *The Sky at Night*, 'Brits in Space', Maggie and guest presenter Jen Gupta talk to people who are significantly better suited to space travel than I am. It's a ridiculously exciting episode, giving insights into what it really takes to become one of the select few allowed the opportunity to venture away from Earth's atmosphere. It's particularly brilliant to see the return of John McFall, the world's first astronaut with a physical disability.

Who gets to go?

Here's what I'm curious about: how is it that the ESA has done feasibility studies regarding disabled astronauts, and is green-lighting McFall for a long space mission, but we still don't have disability representation in Antarctica? Bases in Antarctica, such as Concordia Station, have long been used for proxy studies on the impact on the body of extreme conditions. There, just as in space, you can't be evacuated immediately if something goes wrong, making it an even better site for feasibility experiments. To the best of my knowledge, disabled tourists can visit Antarctica, but even stations closer to the coast with less extreme conditions don't have expeditioners or researchers with physical disabilities. And it baffles me a bit.

Prior to my own expedition to Concordia in 2021, I had to undergo a series of medical tests to ensure I was healthy enough to participate. It's standard practice, as any health ticking time bombs would rule you out. However, it's very clear that you can have a physical disability and still be fit and healthy. As Alice Oates argues in her Antarctic Disability Project, Antarctic research is missing out on some serious talent by excluding disabled folks.

As the idea of space tourism gains more traction, pioneers like John McFall will pave the way for the inclusion of disabled people in the future of space exploration, whether for science or just for fun.

My hope is that long before we reach a time when we're booking holidays on the Moon, we'll have made sure that no one is unfairly excluded from opportunities on Earth because of who they are. ESA is doing the work and, hopefully, Antarctic research bases will follow suit eventually. After all, who knows what knowledge, understanding and friendship we're missing out on by not making space – or anywhere – as inclusive as it reasonably can be?

How to watch
Catch the show on the
BBC iPLAYER

George (bottom right) at Concordia Station, where disability representation is still lacking

The Sky at Night
NOVEMBER
The live special will tackle all your cosmic conundrums
BBC
CURIOUS CASES
4

Space Mysteries

The Sky at Night meets BBC Radio 4's hit science series *Curious Cases*, in this special episode filmed in front of a live audience. *Curious Cases* presenters Hannah Fry and Dara Ó Briain team up with *Sky at Night*'s Chris, Maggie and George to conquer some of the biggest intergalactic conundrums, answering questions posed by both audience members and *BBC Sky at Night Magazine* readers.

BBC Four, **10 November**, 10pm (first repeat will be on BBC Four, **11 November**, 11pm)
Check www.bbc.co.uk/skyatnight for more up-to-date information

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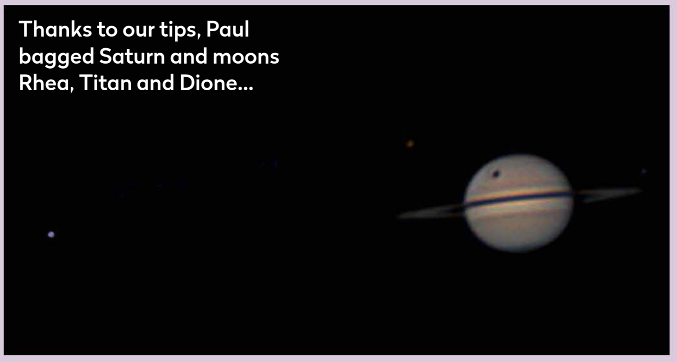
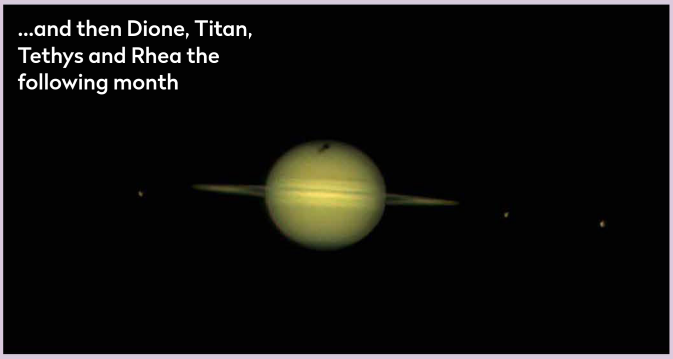
MESSAGE OF THE MONTH

Saturn's moons – right on cue


Thanks to our tips, Paul bagged Saturn and moons Rhea, Titan and Dione...


...and then Dione, Titan, Tethys and Rhea the following month

The magazine's recent alerts about opportunities to see Titan's shadow on Saturn (The Sky Guide, August and September) were fine incentives. The weather here in the northeastern USA was favourable for many of these. The sight of Titan just below and to the left of its shadow on 20 September was particularly gratifying. Here are two of my images taken following your guidance. The first (left) shows Saturn and its moons Rhea, Titan and Dione on 3 August at 0351 EDT, taken with a Celestron NexStar 6SE telescope and a ZWO ASI662MC camera with a 3x Barlow lens fitted. The second (right) shows the view on 20 September at 02:14 EDT, with Saturn and its moons Dione, Titan, Tethys and Rhea, taken with the same setup but using a 2x Barlow. I used SharpCap to get the data and GIMP, Photoshop and Topaz DeNoise AI for the processing. Thank you for the tips!

Paul Lahti, via email

What fine images, Paul! It's great to see you've made such excellent use of our monthly Sky Guide. ***– Ed.***

Which eclipse?

I've been eager to see a total solar eclipse ever since I missed going to Cornwall in 1999. Reading Daniel Lynch's experience ('Capturing the total solar eclipse', at www.skyatnightmagazine.com) has made me even more interested. There's one coming to central Spain next August and another in southern Spain a year later. I can only afford to go to one and am thinking 2027 will be better – it's in the morning and lasts a few minutes longer than the 2026 eclipse, which happens in the evening and so is closer to the horizon. But is there a reason why 2026's might be the better one?

Neil Sage, via email

Both are sure to be amazing, Neil! As for which is better, it depends on what you want from the experience. You're right that for southern Spain in 2027 totality will be longer, but in 2026 the Balearic Islands will experience totality, followed by the Sun setting while still partially eclipsed. Good luck with the decision! ***– Ed.***

Lunar limerick

A few years ago, I wrote a poem after witnessing the waxing gibbous Moon with Jupiter passing my house one night. I then imagined that the Moon and Jupiter would pass by my house the next night as well.

Tonight you'll swing by again
Linger above my roof-top,
A brilliant beacon
Gliding westwards,
A gibbous Moon waxing,
Trailing your girl Jupiter.

I wonder, is this possible? Could there be a repeat performance of the Moon being close to Jupiter?

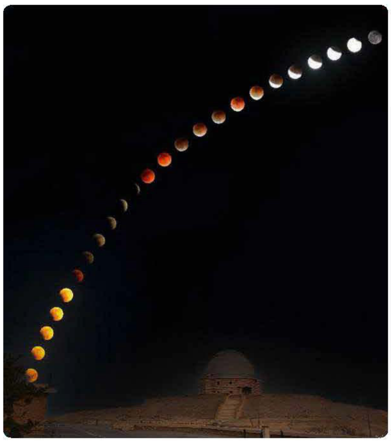
Nollaig Rowan, Ireland ▶

Instagram

mo.faroography • 11 September

A composite of the lunar eclipse over the 74-inch telescope at the Kottamia Astronomical Observatory in Egypt.

@bbcskyatnightmag



BBC Sky at Night MAGAZINE

BBC Sky at Night Magazine is published by Our Media Ltd under licence from BBC Studios, which helps fund new BBC programmes.

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SUBSCRIPTION RATES
Annual subscription rates (inc. P&P): UK cheque/credit card £62.40; Europe & Eire Airmail £75; rest of world airmail £85. To order, call 03330 162119 (UK); overseas +44 (0)1604 973727

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Audit Bureau of Circulations
40,086 (Jan–Dec 2024)

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ISSN 1745-9869

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▶ Thanks for the verse, Nollaig! And yes, a repeat performance is quite possible. The Moon moves eastwards against the stars by about 13° each night, so to the naked eye it can appear close to Jupiter for a night either side of their closest approach. ***– Ed.***

▲ **Nigel's Andromeda Galaxy and sunspots – it's safe to say he's a smart scope convert!**

I'm a believer!

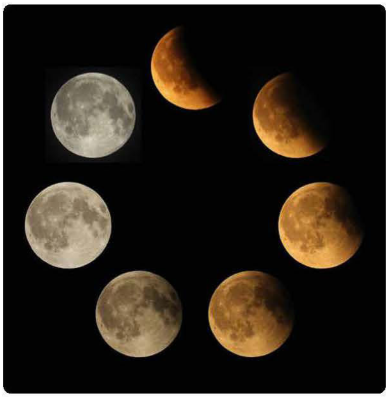
I've used a Meade ETX125PE for years and always dreamed of getting into astrophotography, inspired by the incredible images in *Sky at Night Magazine*. But it's always been an uphill battle, full of frustration. I was sceptical about smart telescopes, until I read your review of the Seestar S30 (June issue) and finally placed an order. I was amazed at how compact it was, and within an hour of clear skies I'd photographed more deep-sky objects than I'd ever managed to see before. I was absolutely astonished. The next morning, I imaged the Sun for the first time and again I was blown away. Thanks for your clear, confident review. For the first time, I feel like astrophotography is not only possible, but enjoyable.

Nigel Hayes, London

Tweet

Epiphany @FunkyAppleTree
• 13 September

Circle of Moons: September's partial lunar eclipse, as seen from London, UK. #BloodMoon #LunarEclipse2025 @skyatnightmag



Moon hopes

I'm very excited to hear that we're attempting to go back into space and land people on the Moon, and quite possibly Mars in the near future. I'm 70 years old and have seen things that I never thought would have happened in my lifetime, like landing a man on the Moon. I don't know if I'll be around to see that again, but I'm hoping that the United States and other countries will coexist and do this together.

Steven Rosen, via email

SOCIETY IN FOCUS

Bath Astronomers is a thriving society with 170 members in the city of Bath, Somerset, UK. Established in March 1976 as Bath Astronomical Society, we'll celebrate our 50th anniversary in 2026 and have a programme of events to build up to the big party. Every year, our volunteers offer views through telescopes in parks, schools, youth groups and on the high street, so it's going to be fun to turn the dial up to 11 for our anniversary year.

In 2025, our members collaborated with the local Herschel Museum of Astronomy to create a dramatic exhibition of amateur astrophotography, alongside the sketches by William Herschel of the same targets. Beyond our classroom and stargazing visits, we've delivered life-sized cut-outs of Dr Rosemary Coogan – the UK's next astronaut – to local schools, to help inspire the next generation of scientists, engineers and explorers.

SIMON HOLBECHE

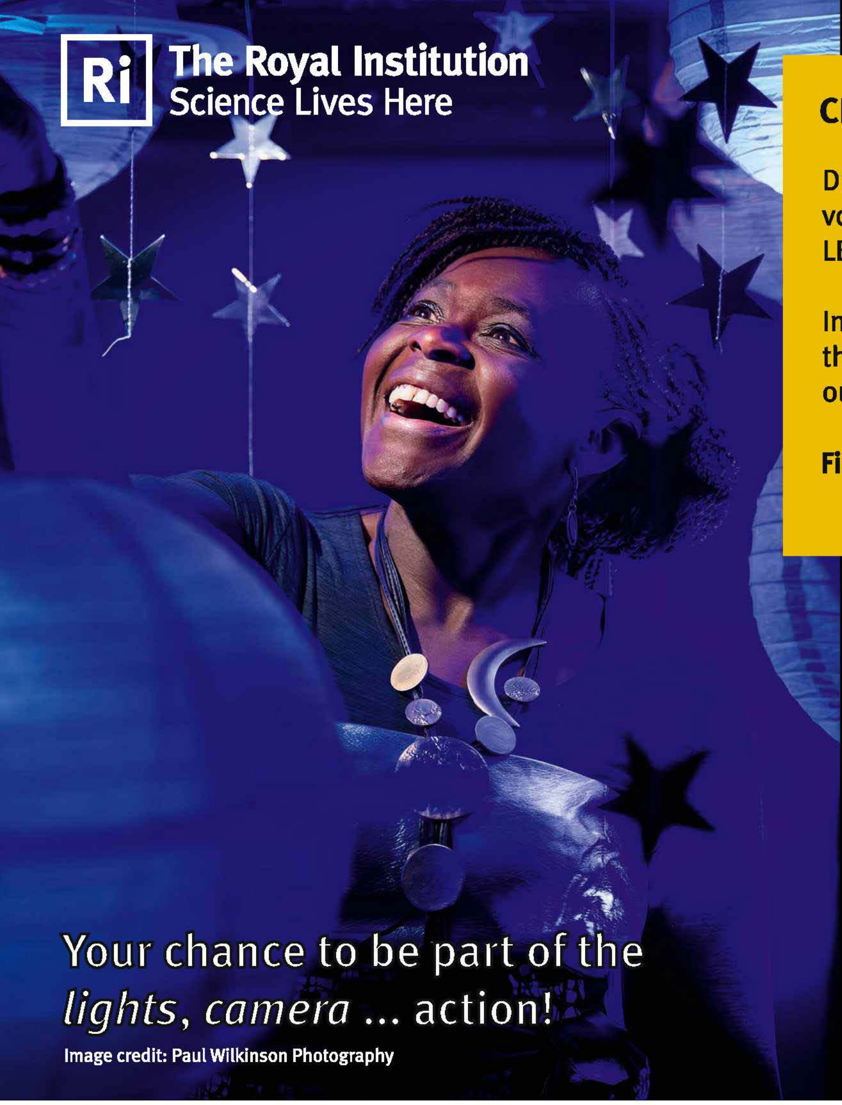
▲ **Watching the Perseids meteor shower just outside Bath earlier this year**

Our members are especially proud of giving those schools over 1,000 pairs of solar eclipse glasses for the partial solar eclipse last March.

Providing amazing monthly talks, sharing equipment, knowledge and experiences, and supporting the enjoyment of the night sky will all be as important to us in 2026 as it was 50 years ago.

Simon Holbeche, chairperson

▶ **www.bathastronomers.org.uk**



The Royal Institution
Science Lives Here

Your chance to be part of the
lights, camera ... action!

Image credit: Paul Wilkinson Photography

Science talks

CHRISTMAS LECTURES from the Royal Institution

Dr Dame Maggie Aderin-Pocock will take us on an epic voyage through time and space in the 2025 CHRISTMAS LECTURES from the Royal Institution, supported by CGI.

In this 200th anniversary of the Lectures she will explore the extraordinary breakthroughs that have revolutionised our understanding of the universe.

Find out more: rigb.org/christmas-lectures

Upcoming talks in our programme

The quest for life beyond the solar system With Nikku Madhusudhan	Mon 27 October
New quantum world: Spooky physics With Jim Al-Khalili	Fri 7 November
Discourse: Christmas Lecturer 2025 With Dame Maggie Aderin-Pocock	Fri 28 November

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FIELD OF VIEW

Finding peace in deeptime

Daily worries getting you down? Think about the scale of the Universe, says **Mark Westmoquette** – the Big Picture will make those anxieties so much smaller

Author of *The Mindful Universe,* astronomer and mindfulness teacher **Mark Westmoquette** lives with his young family in London and can be reached at www.markwestmoquette.co.uk

Many people say to me: "Whenever I look at the stars, it makes me feel so small and insignificant; it scares me." It's true – from one perspective, we are but a minute speck of dust on a tiny pebble, orbiting a dim star in a galaxy among billions, existing for half a blink of a cosmic eye.

The problem is that this speck of dust easily gets very caught up in itself, always worried, but wanting to feel important. We worry about where our life is going, how to fix the broken toilet, whether to move house, what to cook for dinner tonight… the list goes on. The worries can get so all-consuming that we can't see out through the tangle of thoughts and emotions to see the bigger picture.

To change this thinking, I like to tune into the simple feeling of gravity – to notice my feet on the ground and my sense of body weight. This immediately grounds me back in the concrete here and now, living on terra firma, orbiting a star in a vast Universe. I start to see my worries with the 'deeptime perspective'.

Deeptime is the view that we live in a 13.8-billion-year process of creative evolution that has brought us from the Big Bang through the formation of galaxies, stars and our Solar System, to this moment. It helps us see how we exist as part of an immense web of interconnected events stretching through all time and space.

The deeptime perspective helps us reframe our sense of ourselves. In our everyday anxiety-filled life, we end up desperately trying to protect our ego, seeking reassurance that we're important, or significant, or enduring, grasping on to what we love and pushing away what we don't. We want to feel invincible but feel vulnerable instead, and this leads to poor states of mental health.

Seeing our lives in the context of deeptime shows our ego the bigger, fuller version of ourselves. It puts our worries in perspective: we see there's more out there than our everyday concerns. Suddenly, there's more space. Whether or not I fix the toilet, the Universe will carry on! Earth will continue to orbit the Sun, and stars will continue being born and dying. And that is deeply reassuring.

We have evolved within the Universe, from the same natural processes and physical laws that created spiral galaxies and supermassive black holes. Our bodies are made from the Universe itself – chemical elements that originally formed inside stars billions of years ago.

That means that when we look at the Universe, we are the Universe witnessing itself. I'd say that makes us very significant.

When we look at the stars, we're in the presence of something so vast that it challenges our everyday sense of self and understanding of the world, and this can be threatening. But thinking in deeptime feels safe and reassuring, turning wonder and fear into awe – awe at this incredible Universe, our place in it and our deep connection to it.

ANTOINE CORBINEAU, FOLIO

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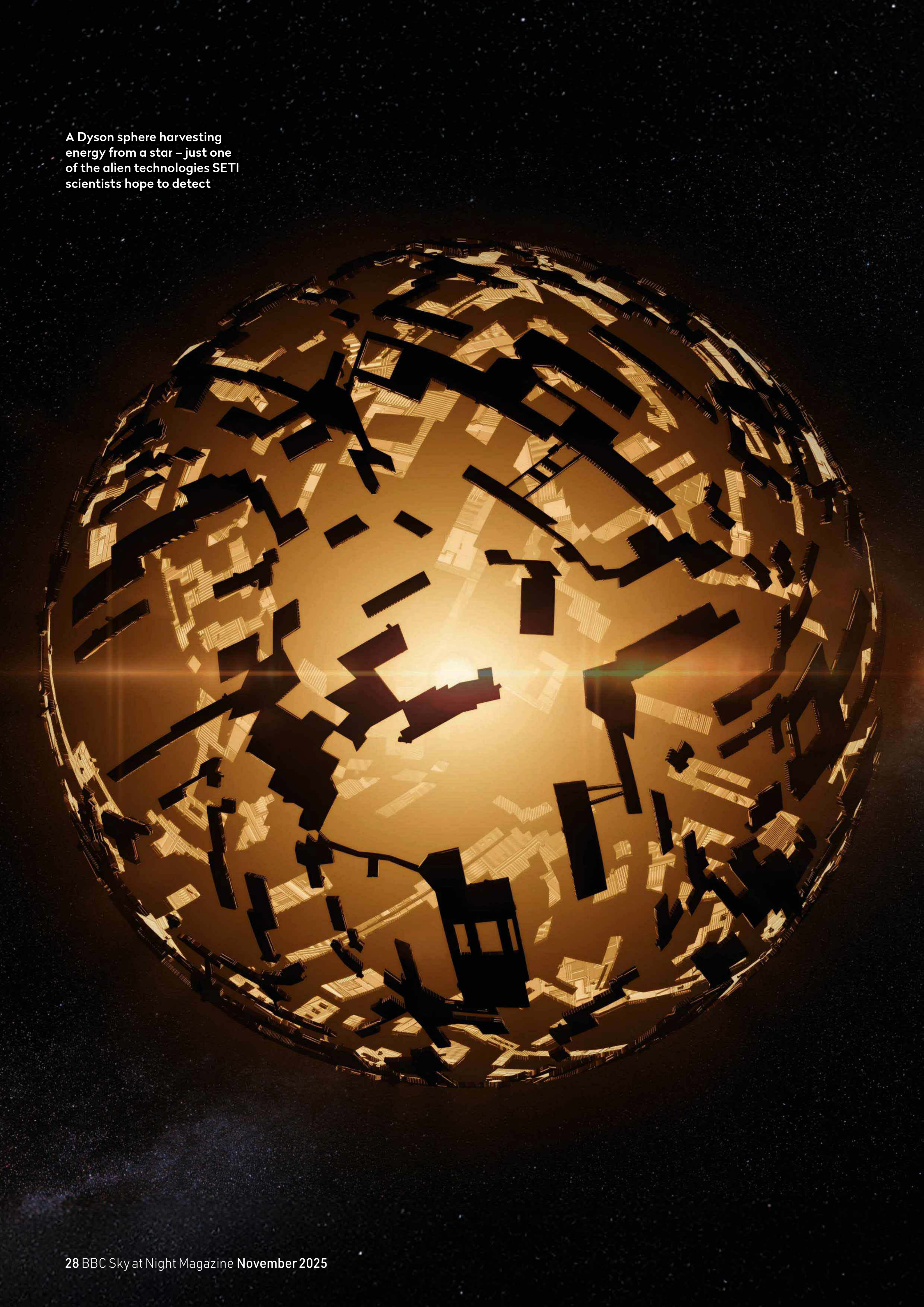


A Dyson sphere harvesting energy from a star – just one of the alien technologies SETI scientists hope to detect

ILLUSTRATION: DOTTED ZEBRA, ALAMY

The hunt for **alien tech**

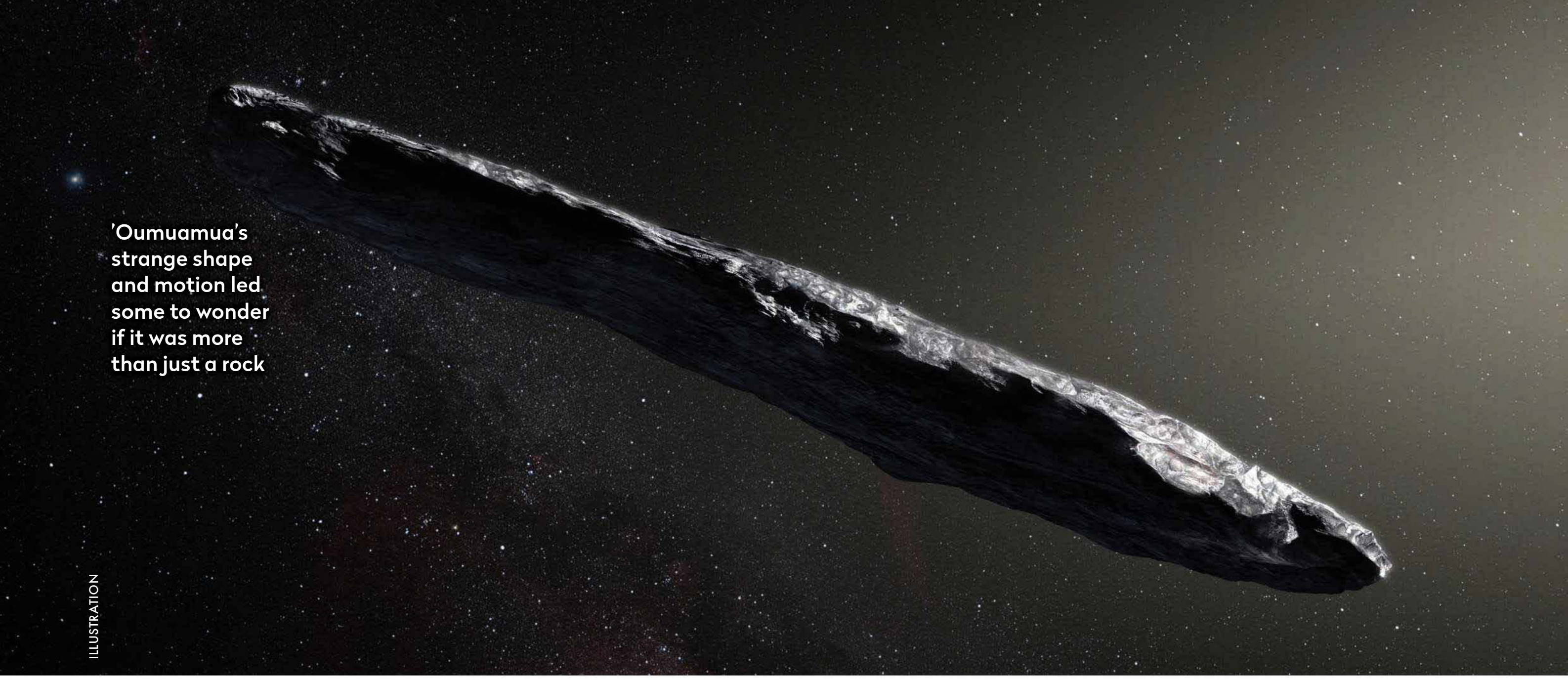
Can scientists tune in to Radio Alien? **Govert Schilling** investigates the cosmic clues that might reveal intelligent life through its technology

When comet 3I/ATLAS was discovered in July, on a one-way interstellar journey through our Solar System, Harvard astronomer Avi Loeb suggested it might be an alien spacecraft paying us a visit. Back in 2017, he made similar claims about the very first known interstellar object, the asteroid 1I/'Oumuamua. In fact, despite their somewhat unusual properties, both celestial bodies appear to be completely natural, and most astronomers dismiss Loeb's speculative assertions.

But what if he was right? What if we really did find a piece of alien hardware?

"Proof of the existence of extra-terrestrial intelligence would be the most important discovery in human history," says Andrew Siemion, principal investigator at the privately funded Breakthrough Listen programme. And while Breakthrough Listen uses radio telescopes around the world to search for possible interstellar broadcasts – an approach known as SETI (Search for Extra-Terrestrial Intelligence) – astronomers are now thinking seriously about how to broaden the search by looking for 'technosignatures', other telltale traces of alien technology. Spaceships, for instance.

The idea isn't new. In his 1973 science-fiction novel *Rendezvous with Rama*, Arthur C Clarke described the discovery and subsequent exploration of a huge alien craft that happened to pass through our Solar System. Five years ▶



'Oumuamua's strange shape and motion led some to wonder if it was more than just a rock

In *2001: A Space Odyssey*, unseen beings leave humanity a mysterious monolith

ILLUSTRATION

▲ Exoplanet K2-18b, where researchers reported hints of dimethyl sulphide, a molecule that's produced by life

▶ earlier, in *2001: A Space Odyssey*, Clarke and director Stanley Kubrick imagined how mysterious beings left huge monoliths behind in the Solar System to guide the slow progress of human evolution.

What alien tech might look like

SETI pioneer Jill Tarter coined the term 'technosignatures' in 2007 to emphasise that there are multiple ways to search for extraterrestrial intelligence. But while many people believe that UFOs (unidentified flying objects) and UAPs (unidentified aerial phenomena) are proof of alien visits, no one has ever come up with undisputed evidence that ET has rung our doorbell.

Then again, evidence of alien technology might also be found in the distant Universe, and not just in the form of artificial radio messages. In fact, any weird, inexplicable astronomical observation could potentially hint at the existence of extraterrestrial intelligence (though most astronomers like to warn: "It's never aliens"). Jason Wright of Pennsylvania State University, for one, likes to keep an open mind. "Is it likely that we will ever discover technosignatures?", he asks. "I don't know, but I enjoy exploring the idea."

In 1959, physicists Giuseppe Cocconi and Philip Morrison first suggested that radio telescopes could be used to eavesdrop on alien communications. At the time, no one had a clear idea of how likely extraterrestrial life, let alone extraterrestrial intelligence, might be. Today, things look very different. We now know that planets – including temperate, water-bearing worlds like Earth – are plentiful, and that the carbon-based building blocks of life are all over the place in the Universe. It seems incredibly unlikely that life has only emerged once.

Using sensitive instruments such as the James Webb Space Telescope, astronomers are now able to sniff out the atmospheres of nearby exoplanets in the hope of finding so-called biosignatures – molecules that hint at biological activity on an alien planet's surface. So far, no convincing detections have been reported (although a team led by Cambridge astrophysicists has claimed the detection of dimethyl sulphide in the atmosphere of planet K2-18b) and the discovery of biosignatures may have to wait for future facilities like the European Extremely Large Telescope or NASA's proposed Habitable Worlds Observatory.

If biosignatures are already so hard to find, you might expect the search for technosignatures to be even harder. After all, biosignatures are produced by each and every form of life – even single-celled organisms – while technosignatures require the

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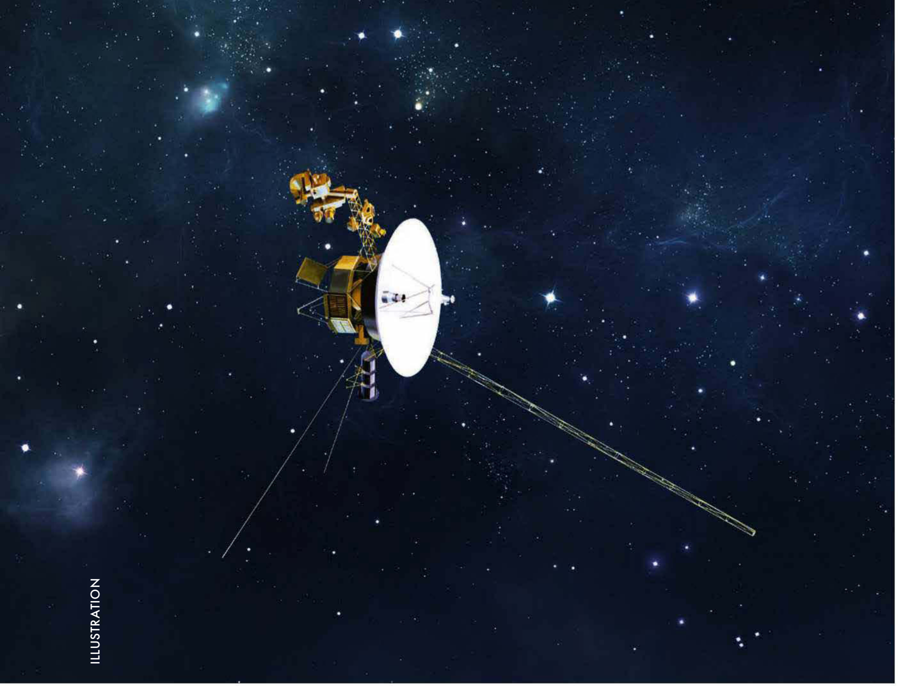
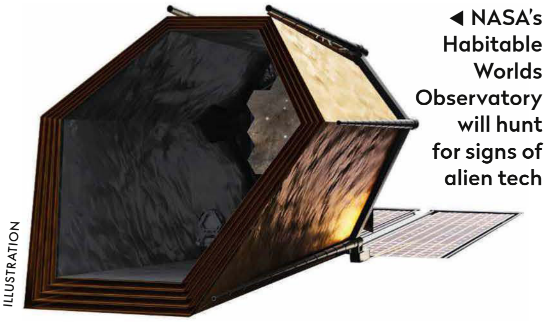


▲ **Voyager reminds us that technology doesn't have to stay home. Could alien tech be drifting through deep space too?**

emergence of intelligence and technology. But in a 2022 paper, Wright and his colleagues argued that technosignatures (including radio transmissions) might actually be *easier* to detect.

For one thing, they could be more abundant, as one single technologically advanced civilisation might spread across multiple planets or even planetary systems. Humanity itself is a case in point, albeit at a modest level: while our biosignatures can only be found on Earth, our hardware is scattered throughout the Solar System – and even beyond.

Moreover, artificial structures could outlive their makers. Even if the intelligent aliens become extinct, their environmental impact, buildings, machines or self-replicating robots could remain detectable for a very long time. For example, the Voyager space probes will still peacefully roam the Milky Way long after the Sun and Earth have gone.



◀ **NASA's Habitable Worlds Observatory will hunt for signs of alien tech**

Technosignatures – in particular, radio signals – can also be detected over much larger distances than biosignatures, which can only be found (if at all) within a few tens of lightyears. And finally, according to Wright and his co-authors, technosignatures are much less ambiguous. While molecules like oxygen, ozone, methane and even dimethyl sulphide can also be produced by non-biological processes (at least in principle), the discovery of a black monolith on the Moon, or a radio signal containing the first million decimals of pi, would be definitive proof of extraterrestrial intelligence.

Are aliens harvesting stars?

One particular type of potential technosignature (other than alien radio transmissions) was described by visionary Princeton physicist Freeman Dyson back in 1960, just one year after the landmark paper by Cocconi and Morrison. Long before infrared astronomy seriously took off, Dyson suggested searching for weird infrared stars. These, he argued, could be huge artificial spheres, constructed by a highly advanced civilisation around their parent ▶

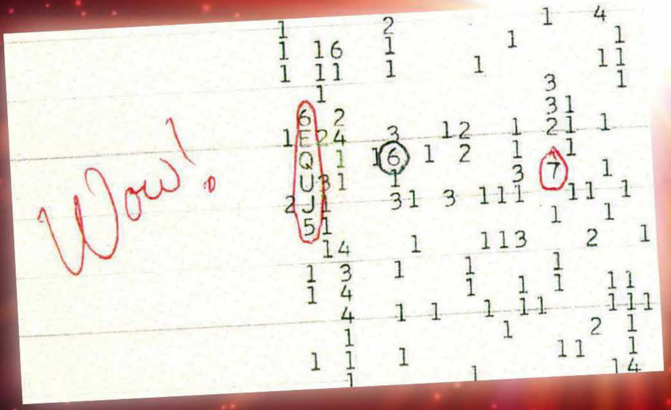
The Wow! signal

Almost 50 years after it was picked up, the jury's still out on the most famous alien call of them all

On 15 August 1977, Ohio State University's 'Big Ear' radio telescope picked up an extremely strong, 70-second narrowband signal originating from somewhere in the constellation Sagittarius, the Archer. When volunteer Jerry Ehman checked the receiver output – an old-fashioned strip of paper from a line printer – he noticed the character string 6EQUJ5. Ehman circled it with a red pencil and wrote "Wow!" in the margin.

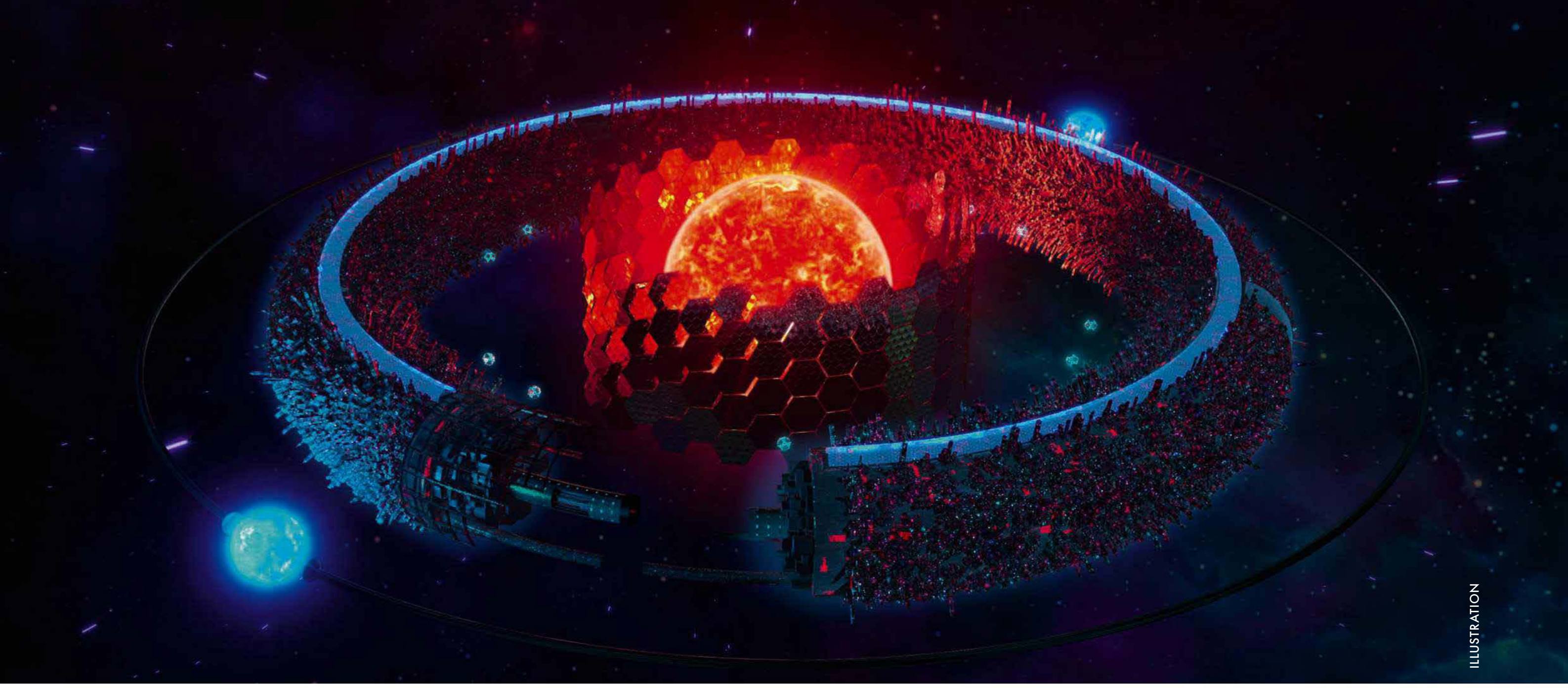
The Wow! signal remains one of the most famous candidates for an alien radio message. By the way, if you're wondering what aliens might have meant by 6EQUJ5, the characters were just a nerdy way to describe the rise and fall of the signal's power.

Remarkably, the signal had a radio frequency of 1,420MHz, which physicists Giuseppe Cocconi and Philip Morrison had proposed in their landmark 1959 paper as the most promising frequency to search for interstellar messages. It also means that the Wow! signal – which has never been detected since – probably wasn't terrestrial interference, as this frequency band is reserved for radio astronomy.



▲ **The Wow! signal: a 70-second radio burst detected in 1977 – and still unexplained to this day**

A recent re-analysis by radio astronomer Abel Méndez and colleagues suggests that the signal may have been caused by a rare maser-like burst of radiation from a cold cloud of interstellar hydrogen gas. But the mystery is far from solved.



▲ An imagined ringworld wrapped in alien engineering. Unusual signals or emissions could give such worlds away

▶ star, to collect as much energy as possible. Physics dictates that the outer surface of such a sphere would emit infrared radiation.

The idea was first proposed by science-fiction writer Olaf Stapledon in his 1937 novel *Star Maker*, although the concept has subsequently become known as a Dyson sphere. According to Wright, it's not very far-fetched. "Collecting energy is probably a fundamental and universal trait of intelligent civilisations," he says. Perhaps you don't need a complete sphere, but even a huge ring of energy-collecting solar panels would be detectable through its heat radiation, or because it might block some of its star's light.

In fact, when Tabetha Boyajian of Louisiana State University announced the discovery of the weird, irregular fluctuations in the light of 'Tabby's Star' – the star KIC 8462852 – back in 2016, some researchers (including Wright) suggested that it might be surrounded by a partly completed Dyson sphere. Similar suggestions have been made for other stars with hard-to-explain brightness variations or with larger-than-expected infrared excesses.

Although the behaviour of Tabby's Star still isn't fully understood, most now believe the brightness fluctuations are caused by an orbiting swarm of giant comets or the debris of a disrupted asteroid. Apparently, technosignatures are not

Listening for ET

MeerKAT, Parkes, Green Bank and more – today's SETI radio searches span the globe

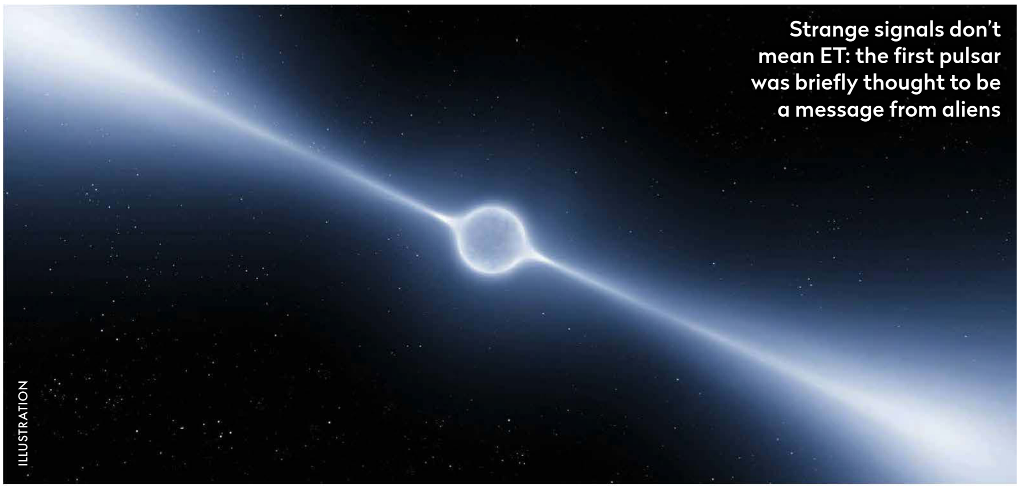
Since the pioneering work of radio astronomer Frank Drake in the early 1960s, many projects have searched for artificial radio signals from outer space. Over the decades, the sensitivity, bandwidth and computing power of SETI programmes has grown tremendously, but no one has yet received a call from ET.

At present, the 42-dish Allen Telescope Array (ATA) in northern California, named after its main benefactor and Microsoft co-founder Paul Allen, is the only facility almost fully dedicated to the search for extraterrestrial intelligence. The Breakthrough Listen programme, funded by Israeli billionaire Yuri Milner, buys observing time at the 110-metre (360ft) Green Bank Telescope in West Virginia, USA, and the 64-metre (210ft) Murriyang Telescope in Parkes Observatory, New South Wales, Australia.

▲ Funded by Microsoft co-founder Paul Allen, the 42-dish Allen Telescope Array is a key player in the hunt for alien radio signals

In 2019, it detected a signal from the direction of Proxima Centauri. Proxima is our nearest stellar neighbour and has an Earth-like planet orbiting around it. However, BLC1 (Breakthrough Listen Candidate 1) is now thought to have been caused by terrestrial interference.

In addition to ATA and Breakthrough Listen, there are many 'piggyback' searches, where clever algorithms look for suspect signals in the reams of data from big radio observatories. These include the European Low-Frequency Array (LOFAR), the giant Five-hundred-meter Aperture Spherical Telescope (FAST) in southwestern China, the 76-metre (250ft) Lovell Telescope at Jodrell Bank in Cheshire, England, and the 64-dish MeerKAT array in South Africa. If we've found nothing, it's not for lack of trying.



Strange signals don’t mean ET: the first pulsar was briefly thought to be a message from aliens

ILLUSTRATION

▲ Forget microbes, alien megafactories might be the first thing we spot, belching clues into the sky

so unambiguous after all. But Dyson spheres and other potential alien megastructures, as they are collectively called, are still very much on the radar of SETI researchers.

Keeping an open mind

Obviously, it’s hard to carry out a dedicated search for technosignatures as we don’t know what we’re looking for. But according to Siemion, any anomalous astronomical object deserves special attention, as it might be our first encounter with alien technology. For instance, when the first pulsar was discovered in 1967, it received the code name LGM-1, for Little Green Men. Only later did it became clear that pulsars are rapidly rotating neutron stars. Fast radio bursts, first discovered in 2007, have also been assigned to aliens, by (who else?) Avi Loeb.

“I won’t exclude that we will find advanced life before we find micro-organisms,” says Siemion. Even the search for biosignatures could possibly lead to the detection of a technosignature, in the form of chemical pollution of an exoplanet’s atmosphere by large-scale industrial activity on the surface.

Keeping ET in the back of your head is good for science too, according to a 2023 online paper by astronomers Beatrice Villarroel and Geoffrey Marcy. “Many scientists quote the loss of ‘credibility’ of a certain field – either among peers or funding agencies – when big claims of alien life are made to the media,” they write. “On the other hand, research activity is often stimulated by the possibility of discovering alien life, regardless of the outcome.”

Wright admits that the chance of success in the search for technosignatures strongly depends on how often life will result in technology – something we simply don’t know. At the 2024 Life in the Universe symposium in Cape Town, South Africa, eminent paleoanthropologist Yohannes Haile-Selassie of the Institute of Human Origins in Arizona was sceptical. “If we ever find extraterrestrial life, it won’t resemble homo sapiens in any way,” he said. South African archeologist Sarah Wurz voiced a similar concern. “Our present-day technological capabilities are the result of countless evolutionary coincidences and accidents in the past,” she told her audience.

Siemion, who co-organised the symposium, realises that anthropocentrism is a real problem in our thinking about SETI and extraterrestrial technology. “Maybe we’re indeed on a completely wrong track,” he said, staring at his eye-catching, alien-green shoe laces, “and there’s no guarantee that we will ever find extraterrestrial intelligence. But, of course, that doesn’t mean we’re giving up.”

As for visiting alien spacecraft: even though there’s no evidence that the first three interstellar objects to visit the Solar System are anything but natural bodies, the next one could be artificial. That’s why an international group of astronomers, led by James Davenport of the University of Washington and including Jason Wright, Andrew Siemion and *The Sky at Night*’s own Chris Lintott, recently published a paper on how to look for telltale anomalies in the shape, colour and trajectory of the many interstellar objects that are expected to be found by the new Vera C Rubin Observatory in Chile.

Who knows, even comet 3I/ATLAS could be a hollow body harbouring an alien habitat. “The presence of ‘normal’ behaviour, such as natural cometary activity, or surface colours consistent with bare asteroids, should not deter our follow-up observations aimed at constraining technosignatures,” the authors write.

“As with all technosignature searches, if we only look once, we may simply miss an incredibly obvious transmission or signal.”

Govert Schilling’s latest book *The Astronomy Handbook* is published by Black Dog & Leventhal

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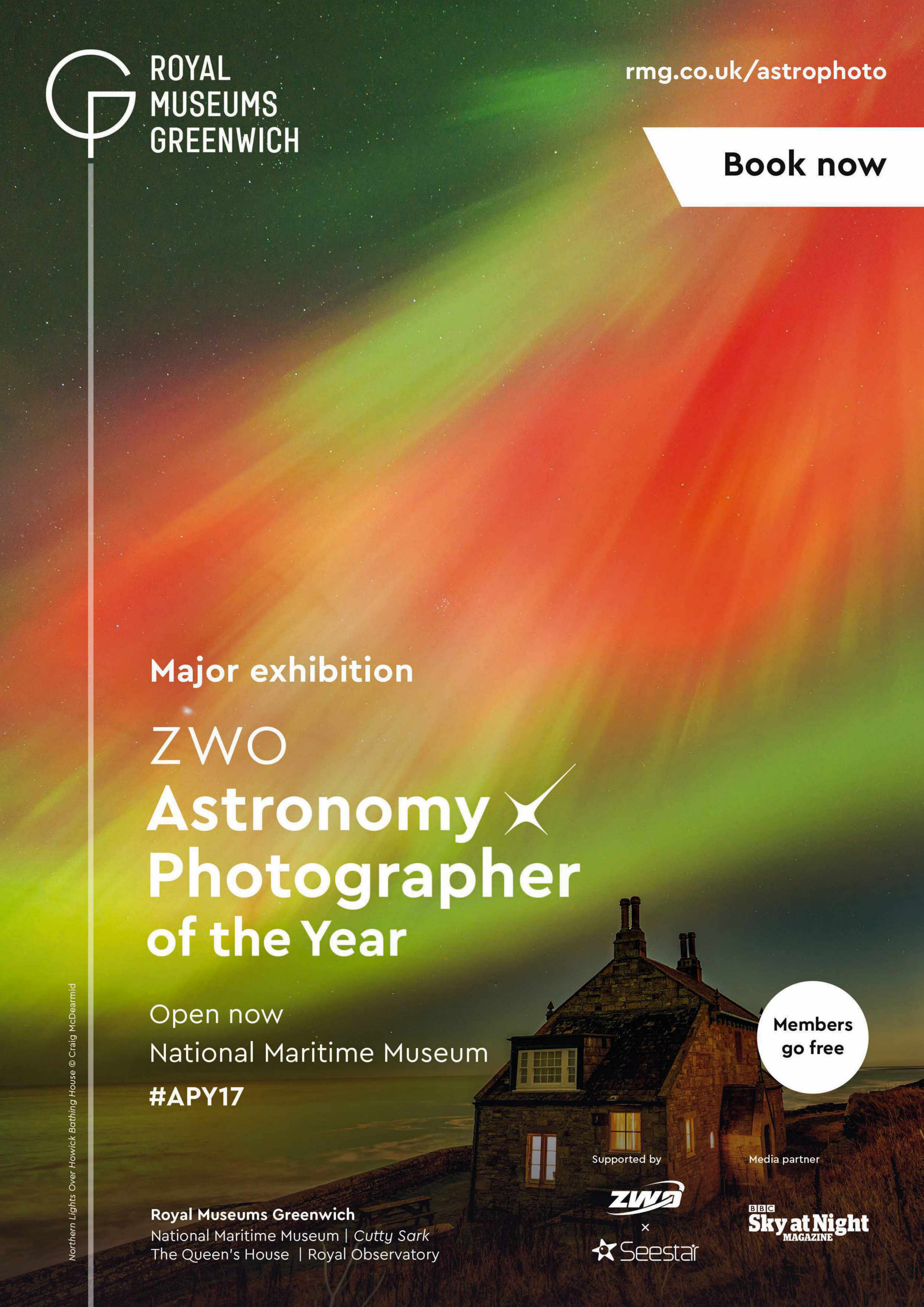

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Northern Lights Over Howick Bathing House © Craig McDearmid

A new generation of tap-and-go smart scopes have opened up the night sky to everyone – no experience necessary

VAONIS

Smart stargazing

A beginner's guide

Curious about smart telescopes? **Jamie Carter** has the low-down on the app-powered tech that's making deep-space imaging easier than ever

Imagine this: you set up a small telescope in your back garden. On your phone's screen, you tap on the Orion Nebula. Seconds later, the scope slews to it, focuses and begins revealing the colourful swirling gas and dust from 1,300 lightyears away – even though you live in the middle of a light-polluted city.

That's the promise of the new wave of smart telescopes. They're compact, app-controlled, robotic observatories that are more like mini versions of the professional telescopes perched on mountaintops in Chile or Hawaii than the refractors and reflectors that have long been at the heart of amateur astronomy.

A smart telescope is a motorised telescope with an integrated camera and onboard computer. In some ways, these fully contained units are similar ▶

Even in light-filled cities, smart scopes put galaxies and nebulae in reach by filtering out glare and combining multiple exposures

▶ to the motorised Go-To telescopes that have been around for decades, but here everything is more digital – and less optical. They're available as refractors and reflectors, in various shapes and sizes, but what they all do is focus the light they collect onto a CMOS sensor, like those found in smartphones (and initially created for use in NASA spacecraft).

Once light reaches the sensor, the onboard computer takes over. Using a process called plate solving, the telescope matches the pattern of stars it sees to a celestial catalogue, determining precisely what it's looking at. It can then slew automatically to selected deep-sky targets, track them precisely and build up detailed images by stacking many short exposures. Sophisticated image-processing algorithms enhance contrast, bring out subtle colours and suppress the effects of light pollution. It's the same process used by deep-sky astrophotographers who assemble their own rigs by putting CMOS cameras on telescopes – but with smart scopes, the entire process is automated.

The resulting image from a smart telescope is displayed not through an eyepiece, but on a connected phone or tablet. Multiple devices can link to the same scope's Wi-Fi network, allowing groups to view the same image as it develops. The longer you leave a smart telescope imaging an object, the better it looks. Once you're happy, you can download the image and share it instantly on social media.

How they find targets

Go-To telescopes have been around for decades. These computerised telescope mounts can automatically point a telescope to objects in the night sky, but only after the user has aligned them by pointing them at two or three bright stars. For beginners, it's a steep learning curve. Smart telescopes, on the other hand, hugely simplify the process. After they're levelled on a tripod and switched on, they take a short survey of the sky to work out their exact position. Even in heavily light-polluted areas, smart scopes can identify enough stars to know precisely where they're pointing.

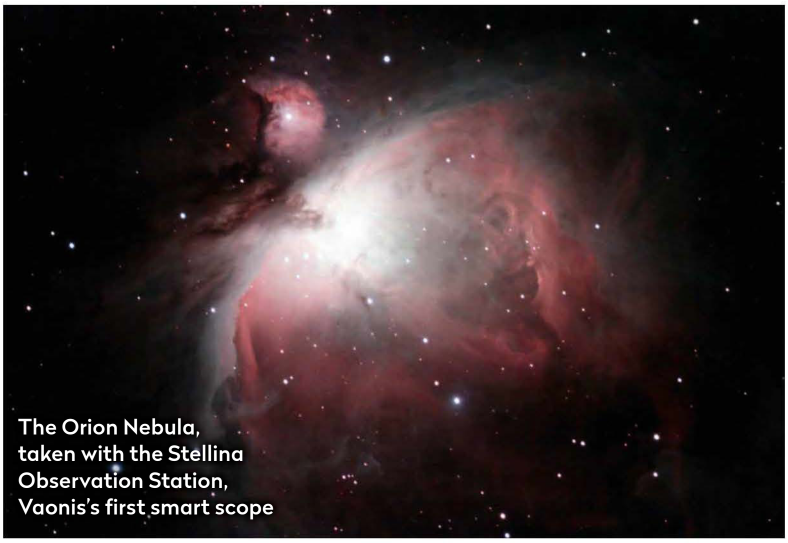
Once aligned, targets can be selected from an on-screen catalogue within a smartphone app; the list can even be automatically filtered to exclude targets that are blocked by trees or buildings. The entire process takes only a minute or two. However, while a Go-To will then allow you to look through an optical eyepiece at the photons coming from deep space, smart telescopes deal only in images.

Tonight
Sunset: 16:42
Astro. Dusk: 18:11
Astro. Dawn: 05:13
Sunrise: 06:40
Last Quarter
49% illuminated, 21.97 days old
Rises 23:36
Sets 12:14
Deep Sky
View All
NGC 210
DARK SKY VIEWABLE
Rises 14:14
Sets 01:07
Andromeda Galaxy - M 31
CITY VIEWABLE
Rises 11:13
Sets 04:12
Sculptor Galaxy - NGC 253
DARK SKY VIEWABLE
Rises 14:56
Sets 00:38
Pacman Nebula - NGC 281
DARK SKY VIEWABLE
Rises Circumpolar
Sets Does not set
Pinwheel Galaxy - M 33
DARK SKY VIEWABLE
Rises
Sets
CELESTRON
Origin
AUX1
AUX2
No eyepiece, no problem. Pick an object with the smart scope's app, then watch it appear on your phone or laptop screen

UNISTELLAR X 3 | CELESTRON X 3 | VAONIS

You can be shooting targets in moments, like this Helix Nebula, taken with Celestron's Origin Intelligent Home Observatory

The Triangulum Galaxy, captured with one of the first app-operated smart scopes, Unistellar's eVscope eQuinox


The Orion Nebula, taken with the Stellina Observation Station, Vaonis's first smart scope

UNISTELLAR
Built for travel, they're easy to transport to dark-sky sites

Why they suit modern life

Smart telescopes directly address three significant challenges in amateur astronomy: lack of time, light pollution and the limits of human vision. In that way, they are perfect for urban astronomers who want to get more from the hobby, or who have been disappointed by the lack of targets available to them when using an optical telescope.

Smart telescopes also overcome the eye's inability to integrate light over time. Whereas a human observer sees only what photons arrive in a fraction of a second, a sensor can gather light for minutes or even hours, capturing detail and structure that the eye alone could never detect. The approach mirrors that of professional observatories such as the Hubble and James Webb space telescopes.

Smart telescopes are designed to perform in both light-polluted cities and remote dark-sky locations. Under urban skies, their algorithms make deep-sky observing feasible. Under pristine skies, they produce cleaner, richer images in far less time. You can use them anywhere and pick up where you left off. For example, you could use a smart telescope to capture images of the Orion Nebula from a big city and be impressed, but then add better data to the same image by taking it with you on a trip to the countryside. It's even possible to leave it outside and automate the observation overnight.

Truly travel-friendly

Of course, for a smart telescope to travel, it needs to be portable. Most smart telescopes weigh 5kg–10kg (11–22lb) and are often supplied with dedicated padded backpacks or protective carry cases for easy transport. Battery life varies from 3 to 10 hours, but since most recharge using a USB-C cable, any portable power bank can be used to top them up. However, remote observing trips require planning for power, not only for the telescope itself, but also for the smartphone or tablet controlling it. It's also worth firing up a smart telescope in advance of any planned trip to a remote location, because their firmware and apps require frequent updates.

Smart scopes are mostly self-contained, but two accessories in particular are worth looking into: tripods and filters. A solar filter is a great addition for solar observing and imaging solar eclipses, while some manufacturers also sell dedicated light-pollution filters. For imaging nebulae, dual-band filters are sold that block all wavelengths of light except hydrogen-alpha (Hα) and oxygen III (OIII), to increase the contrast between the object and the sky. The only downside is their high cost. ▶

▲ ZWO's Seestar S30 comes with a solar filter for sunspot shots

◄▲ From premium to pocket-sized: options range from the eVscope 2 at the high end (left) to the tiny, more affordable Dwarf 3 (above)

They're smart – but not perfect

► Smart telescopes are a hugely attractive option, especially for city dwellers, but in practice they do have inherent drawbacks, both in delivering on their promise of effortless, app-driven astronomy and when compared to traditional optical telescopes.

Smart-scope technology is optimised for wide fields of view and excels at showing extended galaxies and nebulae, but it's less effective for close-ups, such as planets (although newer models are improving in this area). Another consideration is that smart telescopes lack eyepieces, so users are viewing processed images rather than light that has travelled directly from the object to their eyes. Purists sometimes feel that this detracts from the experience. Beginners, however, tend to disregard this as a factor.

For experienced astrophotographers, smart telescopes are generally regarded as a portable emergency rig. Although image resolution is improving with every generation, and smart telescopes can be set to output raw image data, they're all built on altazimuth mounts. Those are generally not ideal for deep-sky astrophotography because of field rotation. This apparent rotation of the sky around a point in the field of view causes star trails and blurred images in long exposures, although it's a very minor issue in practice.

Firmware updates can also be frustrating, sometimes preventing the scope from being used until the update is downloaded. Then there are the apps that crash and the sky-alignment software that stalls and takes much longer to work than advertised.

Smart telescopes can bring instant delight, but buyer's remorse is perhaps inevitable. Think of them like smartphones: as soon as you invest, a newer version comes out, with better optics and a higher-resolution sensor. It's also worth remembering that a smart telescope lives or dies by its smartphone app. If the company goes out of business or the app is no longer supported, your smart telescope will be little more than a useless hunk of plastic and glass.

What's on the market?

Smart telescopes start at around £500, but can exceed £4,000. The premium end of the market is led by models such as the Unistellar eVscope 2, a Newtonian reflector with high resolution and citizen science capabilities (data from Unistellar users helped scientists study the effects of the DART mission, NASA's successful attempt to deflect an asteroid in 2022). Like the step-down Unistellar Odyssey Pro, it's equipped with a Nikon-made electronic OLED eyepiece. Another high-end choice is the heavyweight Celestron Origin, which incorporates augmented-reality control and live streaming, but is designed for fixed setups.

More portable, budget-conscious options include the Vaonis Vespera II and Vespera Pro, both small refractors with mosaic imaging modes; the ZWO Seestar S50 and S30, which have quickly earned a reputation for affordable quality; and the DwarfLab Dwarf 3, which is perhaps the most portable of all. Each suits a different kind of user, but all produce impressive images of nebulae and galaxies.

Other products marketed as smart telescopes include Vaonis's Hestia, which uses a smartphone as a viewfinder and camera, but is very basic, and Celestron's StarSense Explore, which analyses the sky via a smartphone and calculates its position in

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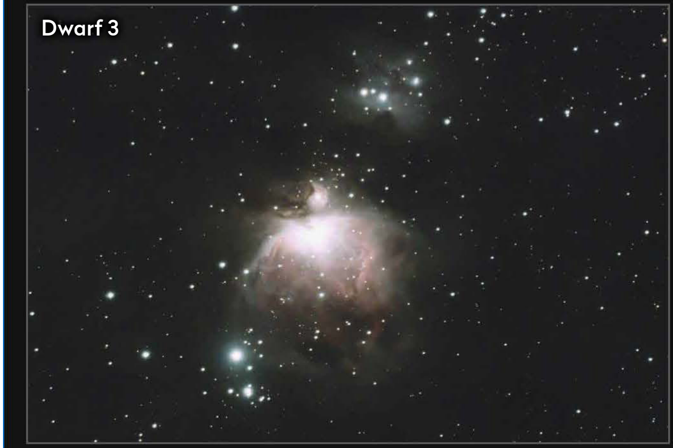
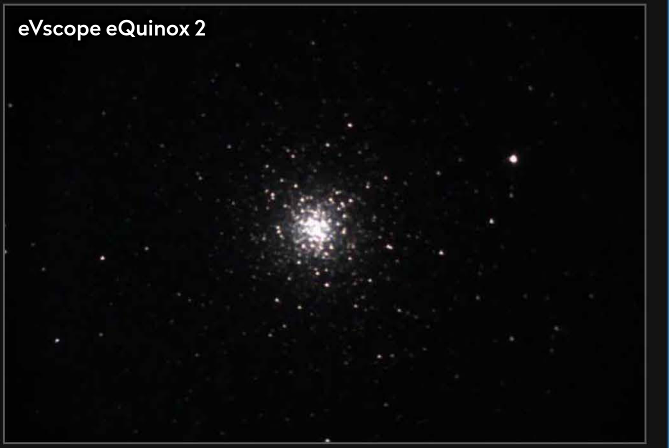
Smart stargazing targets

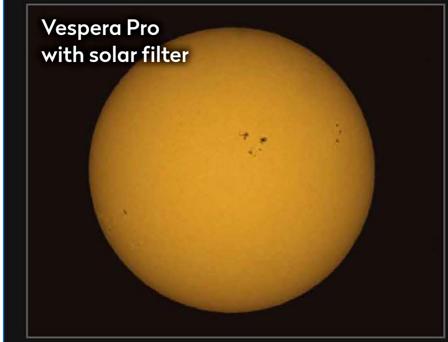
Eight celestial treats to uncover with your smart telescope this autumn and winter



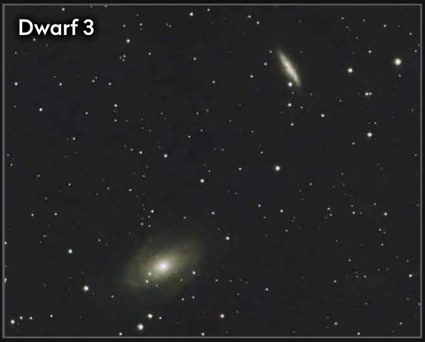
▲ The Orion Nebula: this vivid, large stellar nursery is a must-see



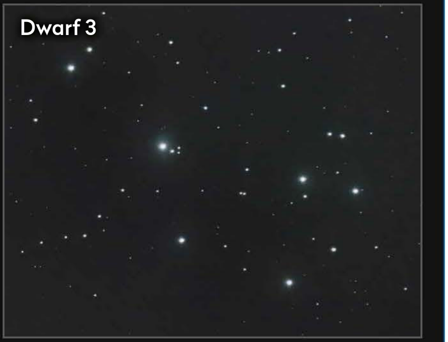
▲ Globular cluster M3, a glittering city of 500,000 stars



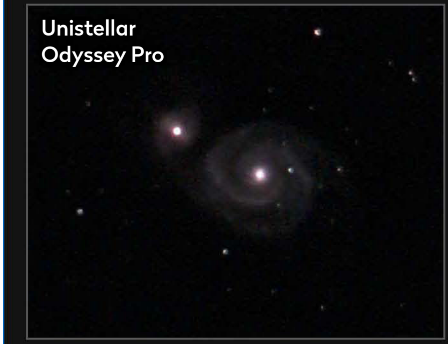
▲ Add a solar filter to safely get up close to our star and see sunspots on its surface



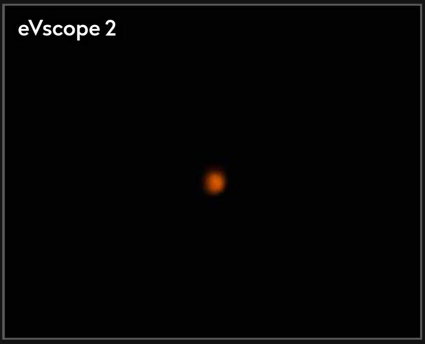
▲ The strikingly contrasting Bode's and Cigar galaxies are rewarding to image



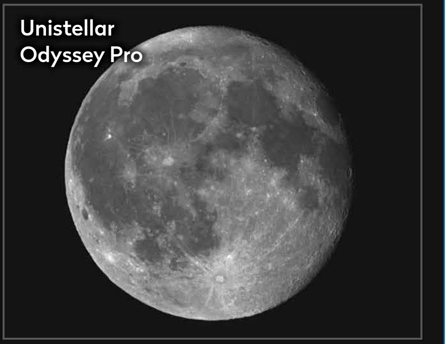
▲ A favourite of the season, the Pleiades is a sparkling star cluster wrapped in mist



▲ The magnificent Whirlpool Galaxy, its arms lit up by bursts of newborn stars



▲ They're not great for planets (yet), but you'll get reasonable views of Mars



▲ Ever-changing and feature-packed, the Moon is one to visit again and again

Jamie Carter is a science and travel journalist, and author of *A Stargazing Program for Beginners*

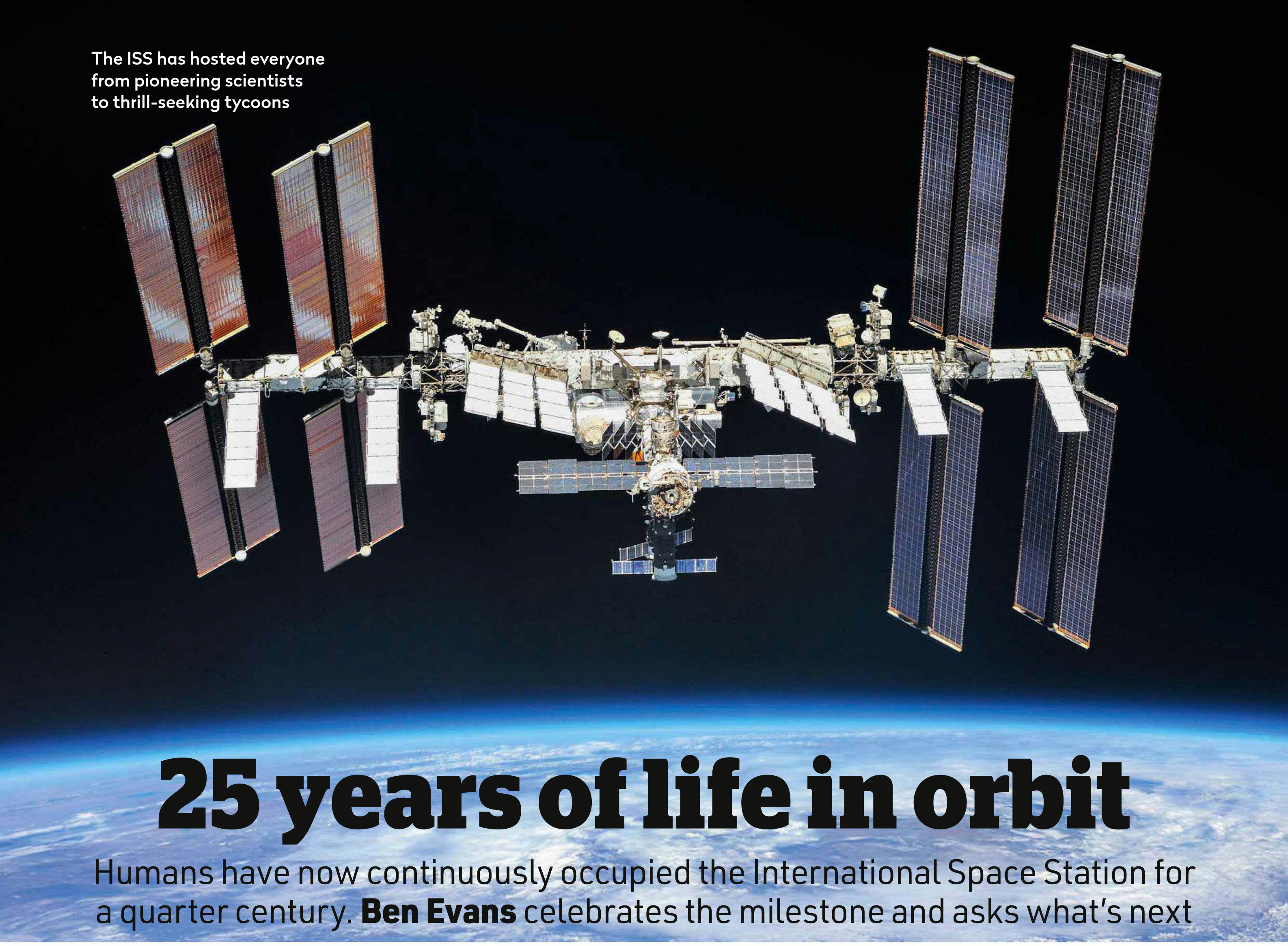
real time, but relies on manual target location and observing through a regular eyepiece.

What's coming next?

As the market quickly evolves, smaller, more affordable models are appearing alongside larger, more capable systems, as well as hybrid designs that can handle both deep-sky and Solar System targets. Connectivity is expanding, with features like augmented-reality control, live-sharing to TVs and the ability to schedule all-night observing runs.

All the while, image algorithms are improving. Some apps now include AI functionality, including spoken chat functions for finding out more about the targets being imaged.

Smart telescopes aren't meant to replace the magic of standing beneath a dark sky with a traditional eyepiece. Instead, they're making astronomy more accessible, overcoming the steepest learning curves and the limitations of poor observing conditions. For newcomers, they offer instant images and insight. For seasoned amateurs, they're a quick, portable alternative when a full setup isn't practical. Whatever your experience level, they open a door to the night sky and usher in a new era of stargazing – one where the Universe is just a tap away.



The ISS has hosted everyone from pioneering scientists to thrill-seeking tycoons

25 years of life in orbit

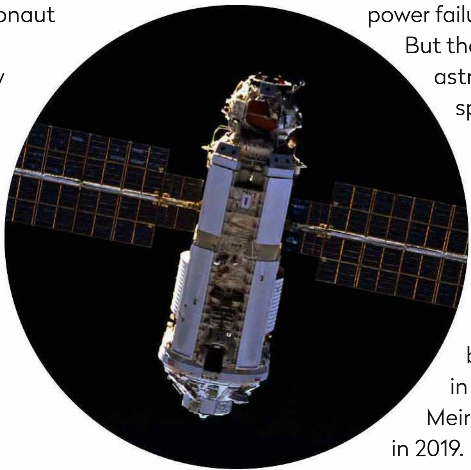
Humans have now continuously occupied the International Space Station for a quarter century. **Ben Evans** celebrates the milestone and asks what's next

On 2 November 2000, a US astronaut and two Russian cosmonauts became the first full-time crew of the International Space Station (ISS). Expedition 1's Bill Shepherd, Sergei Krikalev and Yuri Gidzenko spent four months bringing the station to life – and a new era dawned.

Thus began a 25-year human presence in space. Fast forward to today and the ISS has hosted 290 people from 27 nations. Building, maintaining and operating this Earth-circling marvel – the brightest artificial object in the sky, larger than a football field – is our grandest engineering success and a testament to international partnerships at their best. Put in context, around a quarter of Earth's population alive today has never known a moment when humans were not in space.

When Shepherd's crew arrived, the ISS was the size of a small apartment. Station life proved tough, expeditionary and pioneering, with few creature comforts. In March 2001, Shuttle Discovery brought them home after delivering the Expedition 2 crew. Following nautical convention, Shepherd rang a ship's brass bell to signify the change of command – an ISS tradition that continues to this day.

The station expanded rapidly. Astronauts and cosmonauts performed 275 spacewalks to assemble, upgrade and repair the ISS, tending to occasional power failures, coolant leaks and computer glitches.



▲ Where it started: a single Russian Zarya module was joined by the US Unity module in 1998

But the dangers were acute: in 2013, water entered astronaut Luca Parmitano's helmet during a spacewalk. He only narrowly survived.

Breaking barriers

The ISS hosted the first women astronauts from Canada (1999, during the station's construction phase), South Korea (2008), Italy (2014), Saudi Arabia (2023) and Belarus (2024). Peggy Whitson became the first female ISS commander in 2007, while Christina Koch and Jessica Meir performed the first all-woman spacewalk in 2019. In 2020, Koch completed the longest spaceflight by a woman (328 days).

▶ Peggy Whitson (centre) in October 2007 – the first woman commander of the station

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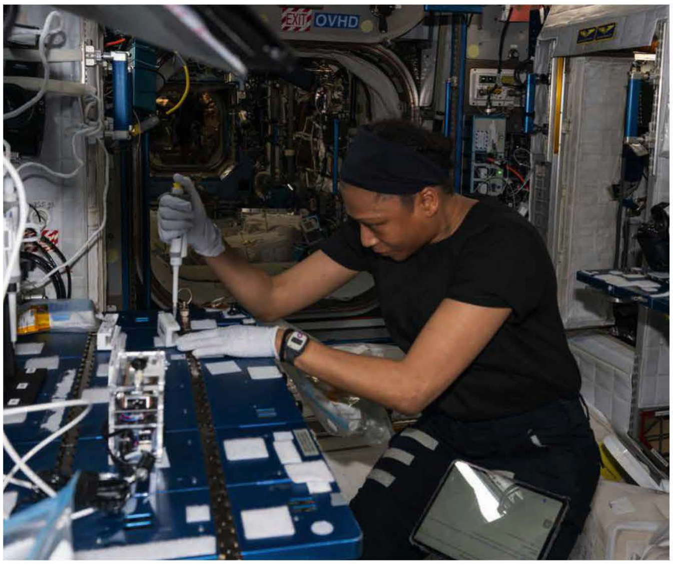


▲ **Flight engineer Jeanette Epps extracts DNA from bacteria colonies in 2024, one of over 3,000 experiments performed on board**

▲ **Chris Hadfield's 2013 *Space Oddity* wowed millions. Instruments aboard the ISS have included flutes, saxophones and bagpipes**

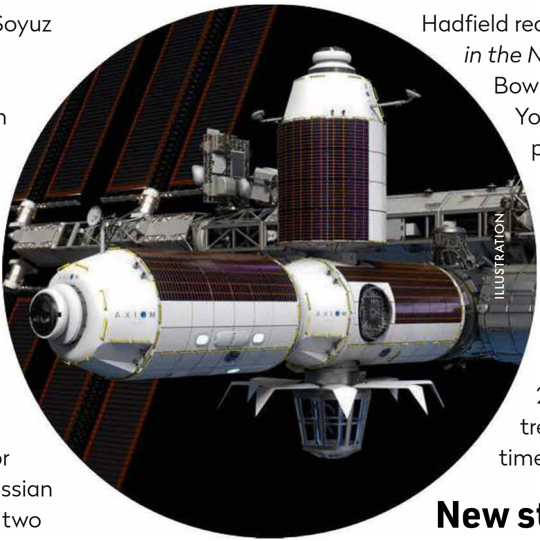
Thirty-seven US shuttles, 70 Russian Soyuz capsules, and SpaceX and Boeing ships assured a steady stream of visitors, including the first astronauts from South Africa (2002), Brazil and Sweden (2006), Malaysia (2007), South Korea (2008), Denmark (2015), the UAE (2019) and Turkey and Belarus (2024). In 2001, Dennis Tito became the first ISS 'tourist', paying £15m ($20m) for a week's stay. Others followed, including Cirque du Soleil co-founder Guy Laliberté. But after the Shuttle's retirement in 2011, all Soyuz seats were reserved for ISS crew, pausing tourism for a decade. When it resumed in 2021, a Russian director shot part of a movie on the ISS, two Japanese tourists visited, and four Axiom missions in 2022–25 featured people from 10 nations, notably 72-year-old Larry Connor, the oldest ISS resident.

Station commanders were usually American or Russian, but the ISS also saw commanders from Belgium (2009), Canada (2013), Japan (2014), Germany (2018), Italy (2019), France (2021) and Denmark (2023). In 2023, Frank Rubio became the first American to spend over a year (371 days) continuously in space.

With US, Russian, European and Japanese lab modules on board, over 3,000 experiments from 108 nations have been performed, from human health to robotics, 3D manufacturing to growing food, Earth observations to astronomy.

It was a fun place to live. Janet Kavandi was the first person to celebrate a birthday there; Mike Fincke was aboard when his daughter was born; Yuri Malenchenko got married here – his bride was in Texas, where long-distance weddings are legal. Ed Lu did magic tricks, Sandy Magnus made cookies, and Greg Chamitoff played chess with mission control.

Music formed a crucial psychological crutch: Catherine Coleman played flute, Thomas Pesquet saxophone and Kjell Lindgren the bagpipes. Chris Hadfield recorded the first song in space, *Jewel in the Night*, and his 2013 rendition of David Bowie's *Space Oddity* went viral on YouTube. Don Pettit won fame for his photography and in 2009 patented a zero-gravity coffee cup. Luca Parmitano – self-styled as DJ AstroLuca – performed a live playlist from space, delighting 3,000 clubbers on an Ibiza cruise ship. Tim Peake, whose first space meal was a bacon sandwich and a cup of tea, 'ran' the 2016 London Marathon on the station's treadmill. The ISS was nominated three times for a Nobel Peace Prize.



▲ **The new Axiom Station will be partly built at the ISS before undocking to form a standalone two-module facility**

New stations, new ambitions

But amid tensions at the start of the Ukraine war in 2022, Russian officials publicly speculated about leaving US astronaut Mark Vande Hei stranded on the ISS, and floated plans to abandon the station entirely. With the ISS only expected to remain functional until 2030, US companies are building their own stations for science, manufacturing, entertainment and tourism. Axiom Station will be partly assembled at the ISS after 2027, then detached as an independent facility. Another US firm, Vast, will launch its Haven station in 2026. Blue Origin and Sierra Space are building Orbital Reef, a 'mixed-use space business park', due to fly in 2027.

Before the ISS ends its days in a blaze of debris over the Pacific Ocean, NASA wants at least one of these commercial stations to be operational, passing the baton from government to private industry. Along with Europe, Japan, Canada and the UAE, the agency hopes to build the Gateway station in lunar orbit after 2027 – a staging point for Moon landings and, ultimately, Mars. But with China aspiring to build its own Moon base after 2030, the next decade promises to open the space frontier as never before. Yet as new stations take shape, the ISS's legacy endures: 25 years (and counting) of humans calling space home.

Science and astronomy writer **Ben Evans** is the author of several books on human spaceflight

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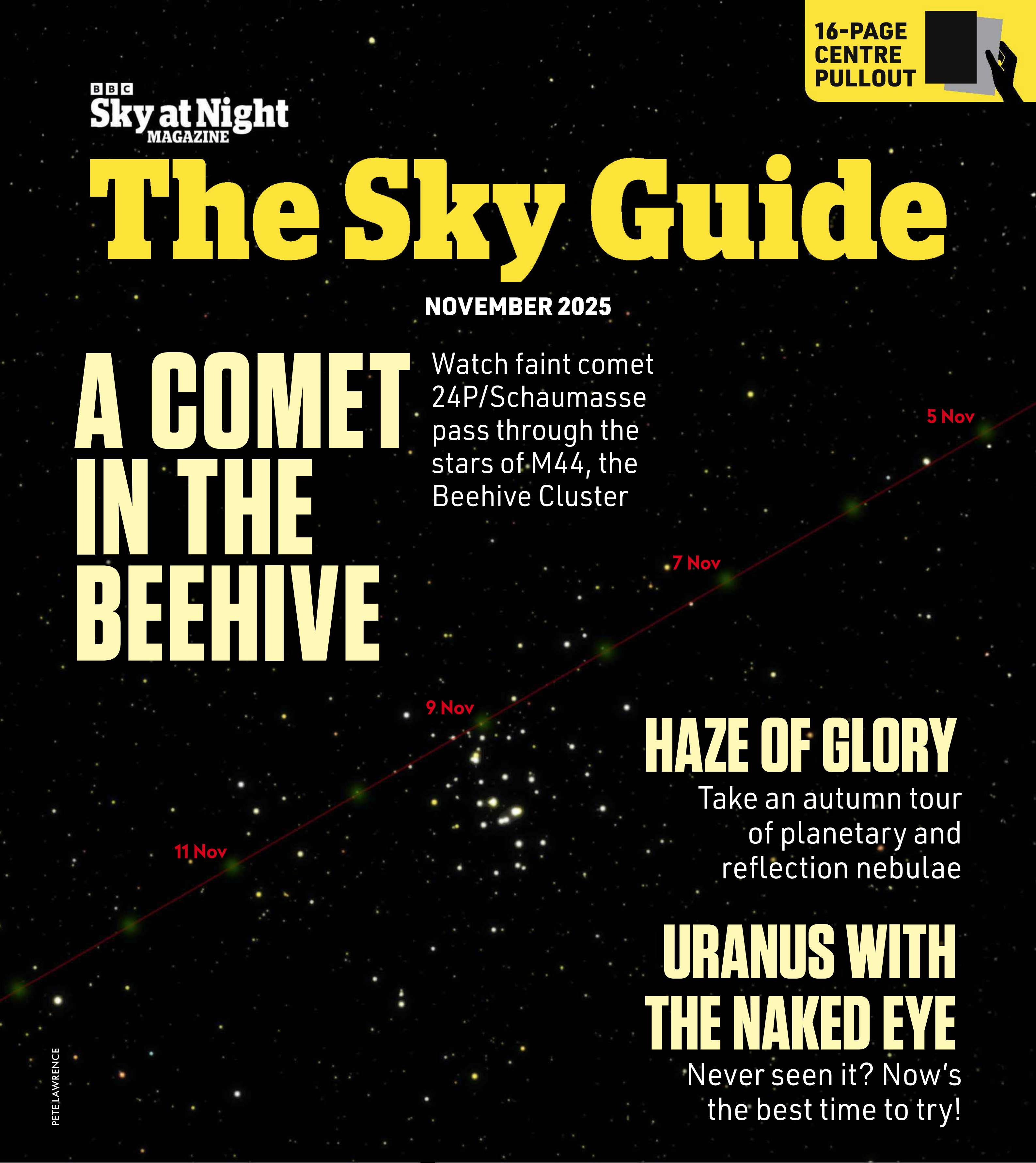
BBC Sky at Night MAGAZINE

The Sky Guide

NOVEMBER 2025



PETE LAWRENCE

A COMET IN THE BEEHIVE

Watch faint comet 24P/Schaumasse pass through the stars of M44, the Beehive Cluster

HAZE OF GLORY

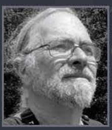
Take an autumn tour of planetary and reflection nebulae

URANUS WITH THE NAKED EYE

Never seen it? Now's the best time to try!

About the writers

Astronomy expert **Pete Lawrence** is a skilled astro imager and a presenter on *The Sky at Night* monthly on BBC Four



Steve Tonkin is a binocular observer. Find his tour of the best sights for both eyes on page 54

Also on view this month...

- ✦ Comet C/2024 E1
- ✦ A ring plane crossing (almost)
- ✦ Lunar crater Byrgius
- ✦ Leonid meteor shower
- ✦ Perigee full Moon

Red light friendly

To preserve your night vision, this Sky Guide can be read using a red light under dark skies

Get the Sky Guide weekly

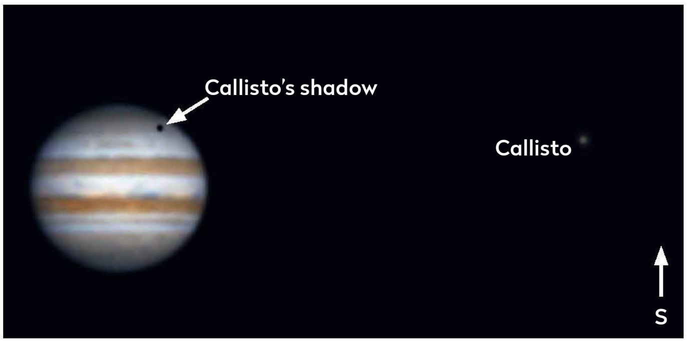
For weekly updates on what to look out for in the night sky and more, sign up to our newsletter at **www.skyatnightmagazine.com**

NOVEMBER HIGHLIGHTS

Your guide to the night sky this month

Sunday

2 Mag. +0.4 Saturn is 5.7° from this morning's 82%-lit waxing gibbous Moon. Catch them together before they set at around 01:00 UT.



◀ Tuesday

4 Callisto's shadow transits Jupiter's disc from 07:01 UT, ending in daylight at 10:36 UT.

Later in the day, catch Callisto itself in transit from when Jupiter rises around 20:55 UT until 22:25 UT.

Thursday

6 An opportunity to see a transit of Saturn's largest moon, Titan, across the planet's globe from 20:33 UT until Saturn sets at 02:33 UT.

Friday

7 Jupiter's largest moon, Ganymede, will be eclipsed by Jupiter's shadow at 04:01 UT.

Saturday

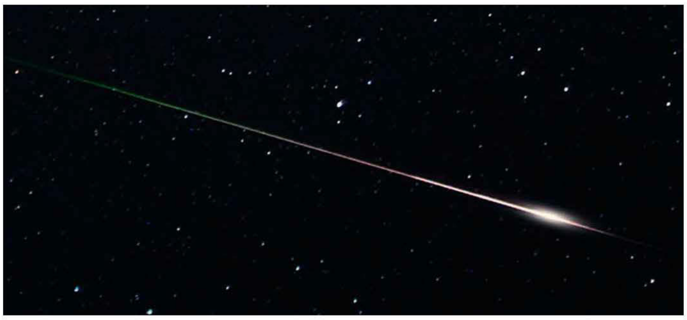
8 Comet 24P/Schaumasse begins to cross the Beehive Cluster, M44. The comet will be at around mag. +13.6, so this event best suits larger apertures or imaging setups.

Monday

10 The 71%-lit waning gibbous Moon sits close to Jupiter this morning. At around 06:00 UT, in brightening twilight, both objects are less than 4° apart.

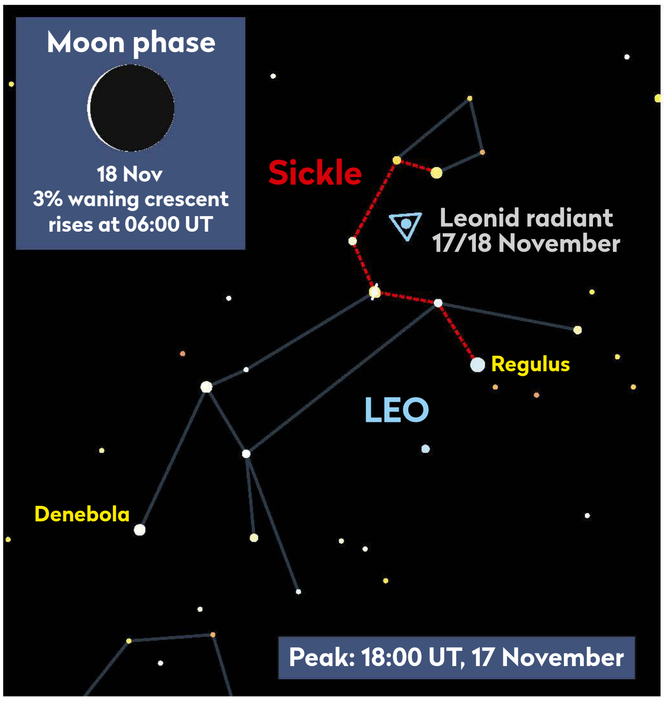
Wednesday ▶

12 Today marks the centre of the broad peak in activity of the Northern Taurid meteor shower. The shower has a low ZHR of 5 meteors per hour.



Thursday

13 Callisto is occulted by Jupiter between 00:55 and 04:57 UT.



PETE LAWRENCE X 6

◀ Monday

17 The annual Leonid meteor shower peaks this evening. The shower's radiant is conveniently located within the head of Leo the Lion, marked by the upper portion of the Sickle asterism. These meteors are very fast, with a ZHR of 15 per hour.

Friday

21 Uranus reaches opposition for 2025.

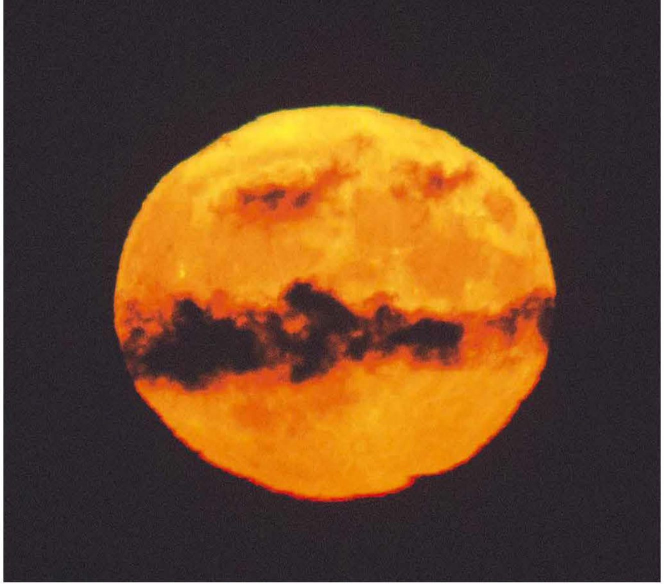
A busy few hours on Jupiter between 01:05 and 04:50 UT, including a double shadow transit by Io's and Callisto's shadows.

Tuesday

25 The shadow of Jupiter's moon Ganymede transits the planet between 02:08 and 05:24 UT. The moon itself transits between 06:09 and 09:29 UT.

Saturday

29 Saturn sits 2.8° south of this evening's 65%-lit waxing gibbous Moon.



Wednesday

5 Today's full Moon occurs at 13:20 UT, just nine hours and 10 minutes ahead of lunar perigee (22:30 UT). This makes it a perigee full Moon, which appears slightly larger than average, with an apparent diameter of 33.3 arcminutes compared to the average of 31.0 arcminutes.

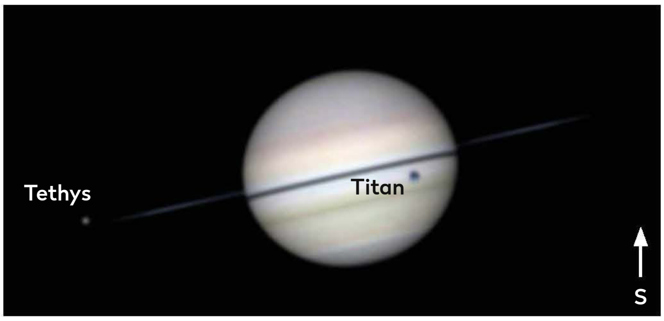
Tuesday

11 The 60%-lit Moon sits very near the Beehive Cluster, M44, this morning.

Saturn's tilt is less than –0.5°, appearing virtually edge-on until 8 December.

Friday

14 Titan is occulted by Saturn at 18:48 UT, reappearing at 00:35 UT on 15 November. The moon then enters a glancing partial eclipse by Saturn's shadow at 01:25 UT. This will be hard to see as Saturn sets at 02:02 UT.



Saturday

22 Titan transits Saturn from 18:52 UT this evening until 01:10 UT on 23 November.

Sunday

30 Titan will be occulted by Saturn between 17:22 and 23:08 UT.

Family stargazing

Now's a great time to show youngsters Jupiter and Saturn through a telescope. Jupiter's slightly flattened globe is impressive, and the four largest moons put on a show of their own as they dance around the planet. A few special moon events are listed in our calendar – see how many you can observe. Saturn looks strikingly different right now, as the rings are virtually edge-on. This is a relatively infrequent occurrence, something that youngsters will remember in the years ahead when the rings open out again. **www.bbc.co.uk/cbeebies/shows/stargazing**

NEED TO KNOW

The terms and symbols used in The Sky Guide

Universal Time (UT) and British Summer Time (BST)
Universal Time (UT) is the standard time used by astronomers around the world. British Summer Time (BST) is one hour ahead of UT

RA (Right ascension) and dec. (declination)
These coordinates are the night sky's equivalent of longitude and latitude, describing where an object is on the celestial 'globe'

Family friendly
Objects marked with this icon are perfect for showing to children

Naked eye
Allow 20 minutes for your eyes to become dark-adapted

Photo opp
Use a CCD, planetary camera or standard DSLR

Binoculars
10x50 recommended

Small/ medium scope
Reflector/SCT under 6 inches, refractor under 4 inches

Large scope
Reflector/SCT over 6 inches, refractor over 4 inches

GETTING STARTED IN ASTRONOMY

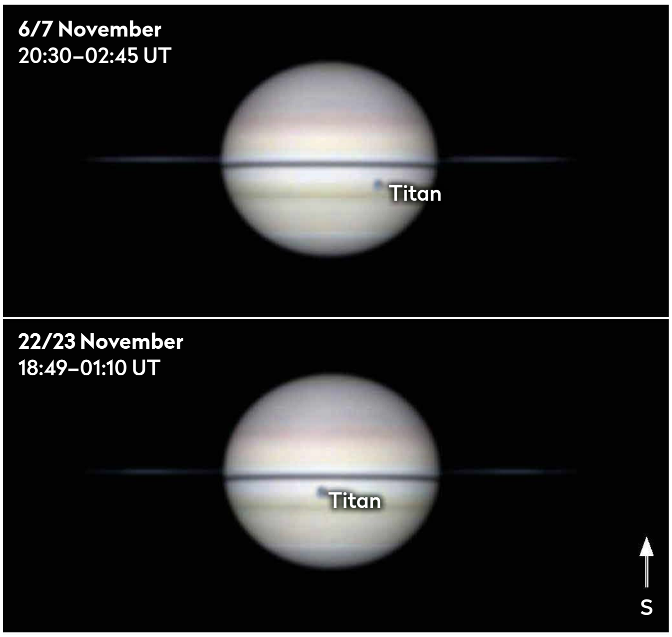
If you're new to astronomy, you'll find two essential reads on our website. Visit **bit.ly/stargazing-top-tips** to learn how to stargaze in 12 easy steps and **bit.ly/choose-first-telescope** for advice on choosing your first scope

THE BIG THREE The top sights to observe or image this month

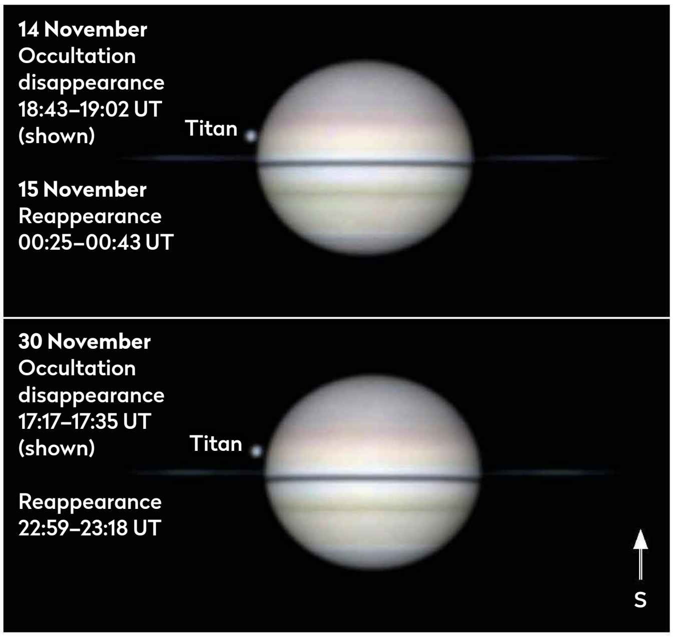
DON'T MISS

(Almost) a Saturn ring plane crossing

BEST TIME TO SEE: Mid-November to mid-December



▲ Saturn is currently edge-on to us, its narrow tilt allowing rare transits of Titan, including these two well-timed events this month



▲ Titan is also occulted by Saturn twice in November. On both occasions, disappearance is more favourable than reappearance

ALL PICTURES: PETE LAWRENCE

Saturn underwent a ring plane crossing back in March of this year, an event which sadly occurred too close to the Sun to be seen clearly. However, the opportunity isn't quite over yet.

Let's explain what a ring plane crossing is. During Saturn's 29.5-year orbit around the Sun, the Sun appears on Saturn's equatorial plane twice, at the Saturnian equinoxes. As Saturn is so far from Earth, we get a similar perspective as the Sun, and the planet appears edge-on to us too. Due to Earth's orbital position, we don't see Saturn edge-on at exactly the same time as the Sun does, but when we do, the 10–30-metre average thickness of the ring system means the famous rings disappear for a short period of time.

Saturn's last equinox occurred on 6 May 2025 and our last ring plane crossing occurred slightly earlier on 23 March. However, although the Sun now appears south of Saturn's equatorial plane, from Earth, the orbital jostling between the two planets continues to cause Saturn to appear to 'wobble' slightly. During the period between mid-November and mid-December, this will reduce Saturn's apparent tilt to just 0.4°, which is about as close as you can get to a ring plane crossing without it actually being a ring plane crossing.

This geometry also brings with it a bonus. Back in March, if we could have seen the actual ring plane crossing, being so close to a Saturnian equinox, the rings would have been casting the thinnest of shadows onto the planet's globe. This would have made the view rather odd: essentially Saturn with virtually no sign of its characteristic rings.

From mid-November to mid-December, this is not the case. Even though we're going to see another very narrow tilt angle, it's the planet's southern hemisphere that's tilted towards us by 0.4° – and the Sun is now higher in the sky from the perspective of that hemisphere. As a consequence, the shadow the rings will cast on the globe will be larger and better defined.

> **"Saturn's apparent tilt will reduce to just 0.4° – about as close as you can get to a ring plane crossing without actually being one"**

Of course, being so narrowly tilted to Earth, we will also get to see rare transits of Titan, something which will continue until February 2026. Unfortunately, the downside of the Sun's more southerly position from Saturn is that Titan's shadow is no longer able to cross the planet's disc. As a result, if you want to see a Titan shadow transit, you'll have to be patient – the next batch starts in around 13 years' time!

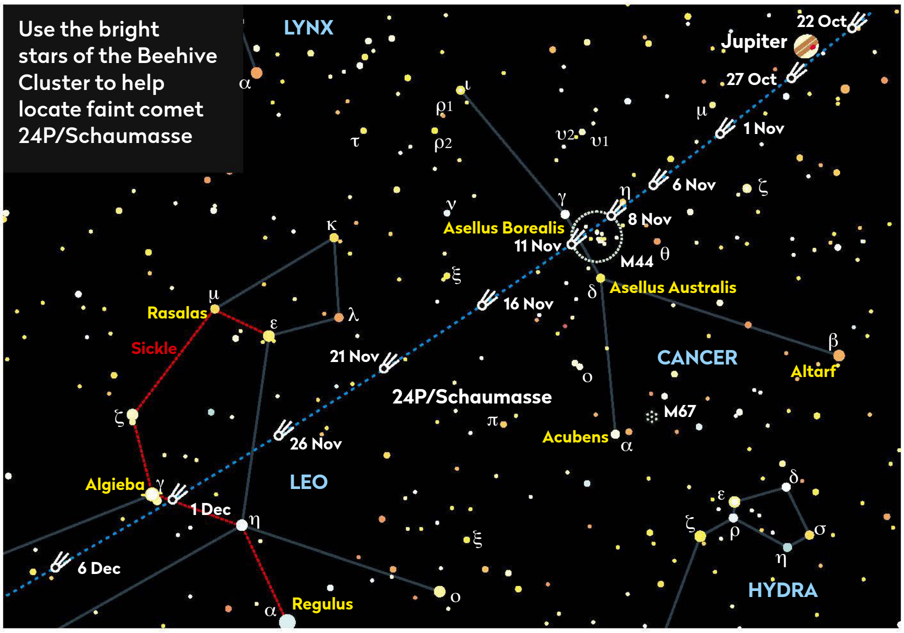
Comet 24P/Schaumasse near the Beehive

BEST TIME TO SEE: 7–10 November and at the end of the month

Comet 24P/Schaumasse will appear to pass across the Beehive Cluster, M44, this month, offering an excellent opportunity to record this relatively faint object. On 1 November, it's expected to shine with an integrated magnitude of +14.3 – that's too dim for small scopes and a challenge for larger apertures. However, if you're set up for imaging, that brightness is well within reach. It's also worth attempting with a smart scope.

There's a catch, though: the Moon will be big and bright in the sky not far from the comet's path. This is where the Beehive Cluster comes in. Its point light source stars will be able to withstand a bit of natural light pollution (moonlight) and should be easy to spot. Knowing where the comet will be passing – even with the bright Moon nearby – gives you a good chance of catching it.

On 1 November at 00:00 UT, the comet will be 7.4° to the west of the cluster. The good news is that it will be brightening as it tracks east towards M44, reaching a magnitude of +13.7 by 00:00 UT on 7 November. At that point, it will sit just outside of the cluster's bounding box, defined by Asellus Borealis (Gamma (γ) Cancri), Asellus Australis (Delta (δ) Cancri), Eta (η) Cancri and Theta (θ) Cancri. It takes the comet three days to cross this box, appearing in front of the cluster on the night of 8/9 November. After that, it continues east into Leo. By the night of 30 November/1 December, 24P will be near the star Algieba (Gamma (γ) Leonis) and will have brightened to mag. +11.6, making it visible to small telescopes.


Use the bright stars of the Beehive Cluster to help locate faint comet 24P/Schaumasse

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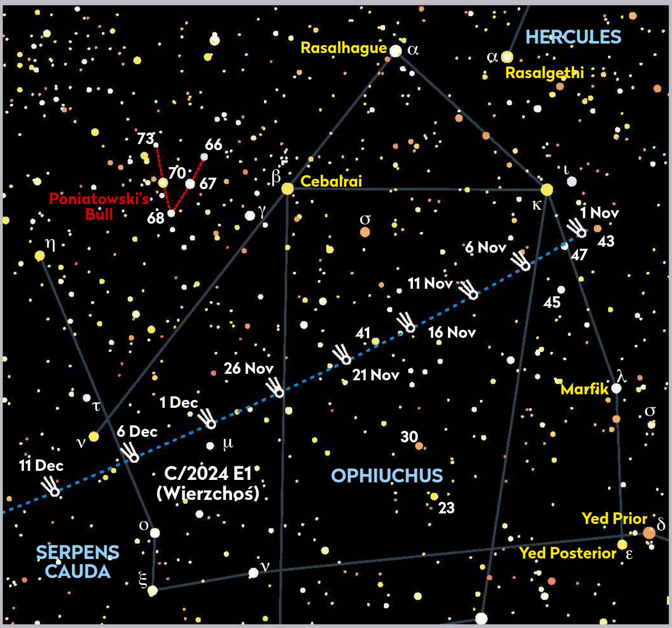
Comet C/2024 E1 Wierzchoś

BEST TIME TO SEE: 8–30 November, just after 18:00 UT

24P/Schaumasse isn't the only comet of interest this month. Another brightening comet is C/2024 E1 (Wierzchoś), which can be found moving across the large form of Ophiuchus, the Serpent Bearer. This spring/summer constellation is still visible under dark skies in the early evening, low above the western horizon.

Comet C/2024 E1 crosses Ophiuchus from a point southwest of Kappa (κ) Ophiuchi at the start of November, to end the month near Mu (μ) Ophiuchi. During this time, it brightens from mag. +11.7 on 1 November to +10.4 on 30 November, making it a viable small-telescope object. C/2024 E1 is predicted to brighten to around fifth magnitude around 20 January, but by then will have moved too far south to be seen from the UK.

Keep an eye out for the comet passing close to mag. +4.7 41 Ophiuchi on the evenings of 18 and 19 November. Its southeast trajectory takes it 2.3° southwest of globular cluster Messier 14 on the night of 26 November – close enough to capture both the comet and cluster in a single frame. Although the Moon will interfere with the view during the early part of November, there should be plenty of opportunities to observe it under clear skies.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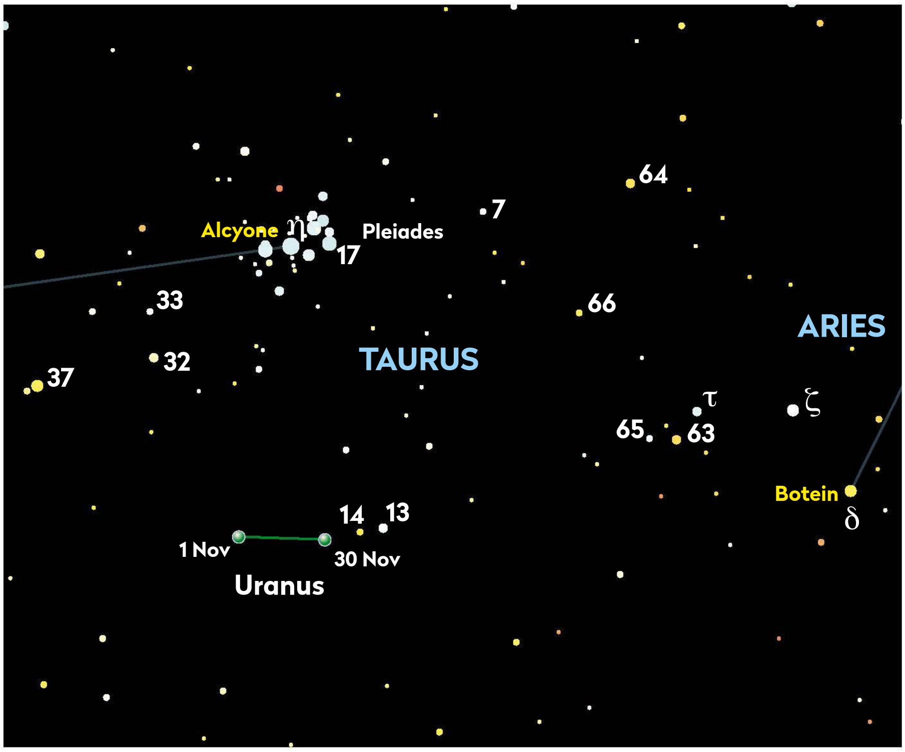
▲ Brightening comet C/2024 E1 crosses Ophiuchus this month

PICK OF THE MONTH

Uranus

Best time to see: 21 November, 23:55 UT
Altitude: 57°
Location: Taurus
Direction: South
Features: Colour, subtle atmospheric bands, moons
Recommended equipment: 200mm or larger


64
7
Alcyone
η
Pleiades
17
33
66
ARIES
32
TAURUS
37
τ
ζ
65
63
Botein
δ
14
13
1 Nov
30 Nov
Uranus

▲ Uranus is currently superbly placed for viewing, south of the Pleiades star cluster

Dim planet Uranus is extremely well placed for observation from the UK in November. It reaches opposition on the 21st and sits 4.5° south of the Pleiades open cluster, M45. This makes it easier to locate than in recent years. It's currently shining at mag. +5.6, which means it should definitely be possible to see with the naked eye from a dark-sky site. Turn to page 55 for this month's challenge, which is all about spotting Uranus without any visual aids.

With optical assistance, Uranus's vast distance means you'll see little more than a tiny, green-hued disc through the eyepiece. In binoculars, it looks just like a sixth-magnitude star, with the planet's characteristic colour being barely discernible. A small telescope will fare better, the colour showing quite well. You'll need at least 100x magnification to resolve Uranus's disc, though you shouldn't expect to see any detail.

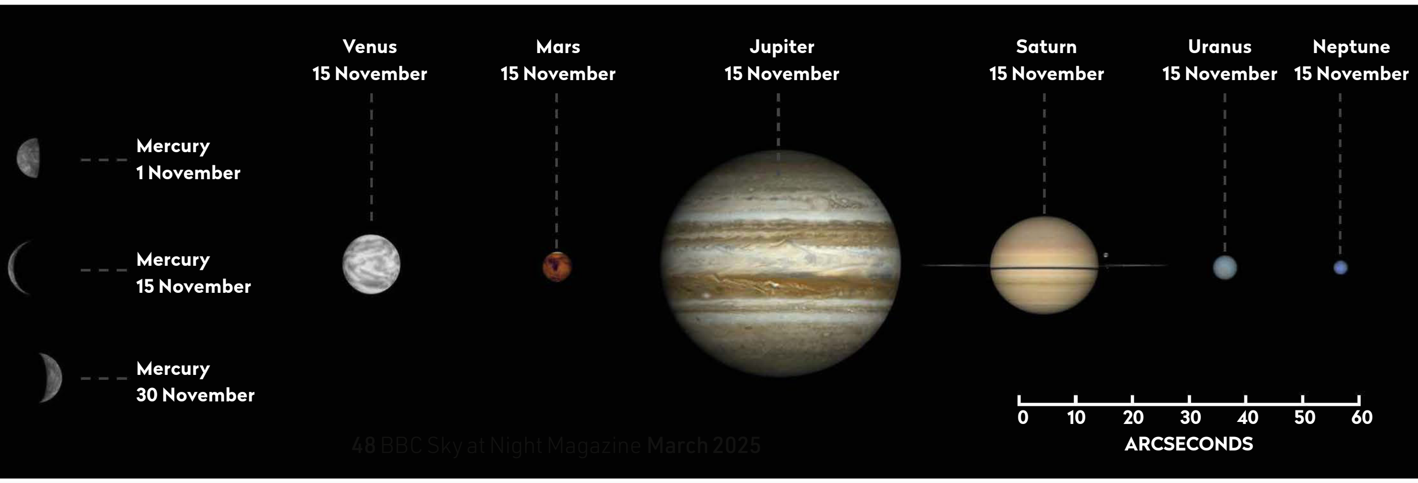
Larger apertures combined with steady seeing conditions and high magnification may show the disc to have areas of different brightness intensities. Experience helps here, as this banding can be extremely subtle. Large-aperture imaging setups may record this detail too, especially when using filters that emphasise green contrast – typically deep-red filters.

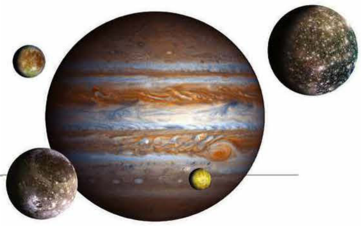
Uranus's brightest moons – Miranda, Ariel, Umbriel, Titania and Oberon – are also viable targets for amateur equipment. You'll need a good image scale (magnification) to see or record them, and if imaging, be prepared to overexpose the planet. Miranda poses the greatest challenge: it remains close to Uranus's glare and is slightly dimmer than the others. While Ariel, Umbriel, Titania and Oberon hover around 14th magnitude, Miranda shines at mag. +16.4.

PETE LAWRENCE X 2

The planets in November

The phase and relative sizes of the planets this month. Each planet is shown with south at the top, to show its orientation through a telescope


Venus
15 November
Mars
15 November
Jupiter
15 November
Saturn
15 November
Uranus
15 November
Neptune
15 November
Mercury
1 November
Mercury
15 November
Mercury
30 November
0
10
20
30
40
50
60
ARCSECONDS
48 BBC Sky at Night Magazine March 2025



Mercury

Best time to see: 30 November, 1 hour before sunrise
Altitude: 5.9°
Location: Libra
Direction: Southeast

Mercury is an evening planet for most of November, but is not well placed after sunset. Inferior conjunction occurs on 20 November, after which it reappears in the morning sky – the best opportunity to observe Mercury this month, when it will be mag. +0.3.

Venus

Best time to see: 1 November, 50 minutes before sunrise
Altitude: 6°
Location: Virgo
Direction: East-southeast

Morning planet nearing the Sun throughout November. Best seen at the start of the month, mag. –3.8 Venus is near mag. +1.0 Spica (Alpha (α) Virginis) at this time. The planet appears 1.1° from Mercury on the morning of 25 November, but with Mercury at mag. +2.1 and both planets in the Sun's glare, this will be a difficult conjunction to see.

Mars

Evening planet, but sadly not visible during November.

Jupiter

Best time to see: 30 November, 03:20 UT
Altitude: 58°
Location: Virgo
Direction: East-southeast

Jupiter is magnificent, reaching peak altitude, due south, in darkness all month. On 1 November, it's highest at 05:15 UT, shining at mag. –2.2. Through the eyepiece, it shows a 40-arcsecond disc increasing to 44 arcseconds by month's end, along with a slight brightness boost to mag. –2.4.

On 10 November, a 71%-lit waning gibbous Moon lies 4.2° north-northwest of Jupiter, most dramatic just before dawn at around 05:05 UT. Jupiter remains in Gemini throughout the month, slightly less than 7° south of Pollux (Beta (β) Geminorum).

Saturn

Best time to see: 1 November, 21:00 UT
Altitude: 33°
Location: Aquarius
Direction: South

Saturn is an evening planet currently in Aquarius, just south of the Circlet asterism in Pisces. On 1 November, it appears at mag. +0.4 with an 81%-lit waxing gibbous Moon 7.3° to the west at 21:00 UT. That separation decreases to 5.5° by the time both set, at around 01:30 on 2 November. On 29 November, mag. +0.6 Saturn has a close conjunction with a 65%-lit waxing gibbous Moon 2.5° to the south. During November, the planet's tilt reduces to 0.4° which means it'll appear virtually edge-on through a telescope.

Neptune

Best time to see: 1 November, 21:30 UT
Altitude: 36°
Location: Pisces
Direction: South

Distant Neptune is currently located near Saturn. Both reach their highest position due south in the evening sky, making them conveniently timed for observation. Neptune requires binoculars to see; at mag. +7.8 it's too faint for the unaided eye. A 67%-lit waxing gibbous Moon sits 2.2° to the north-northwest of the planet early on 30 November.

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Print planet observing forms
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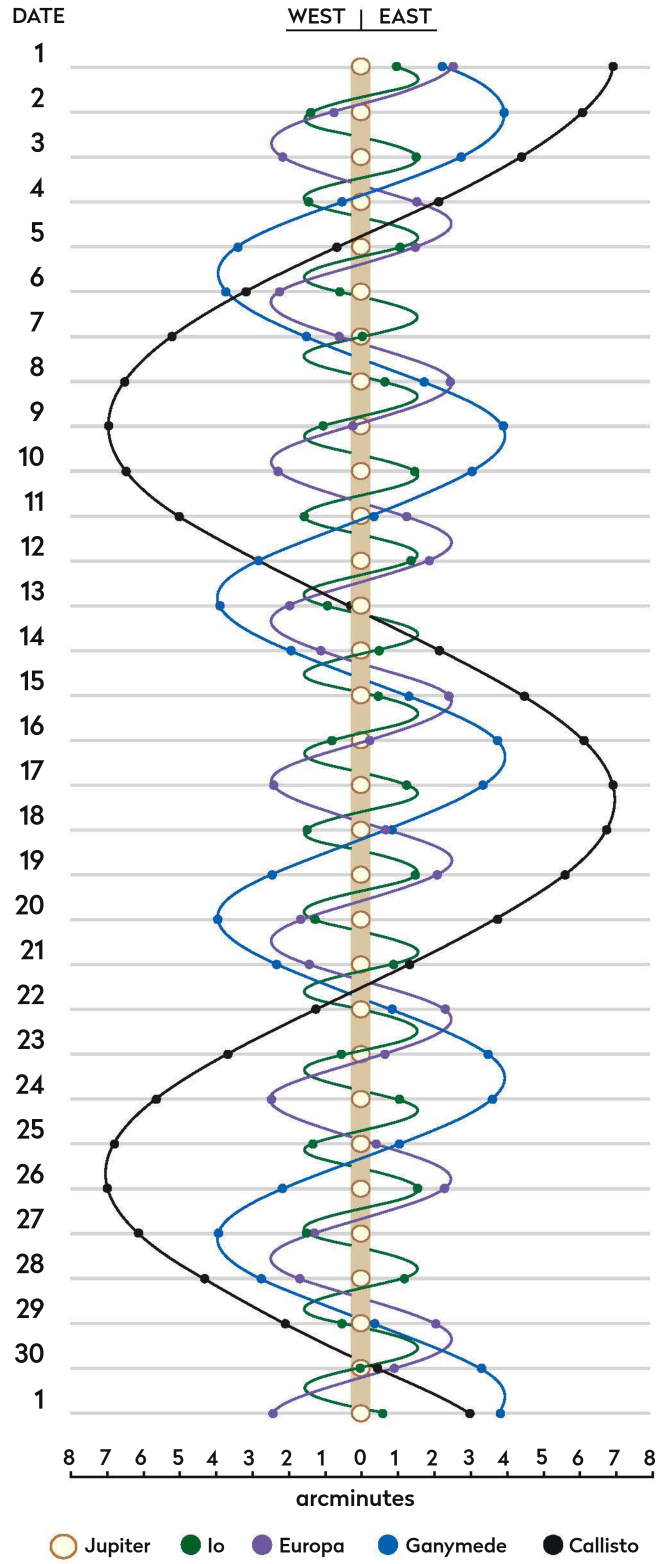
JUPITER'S MOONS: NOVEMBER

Using a small scope you can spot Jupiter's biggest moons. Their positions change dramatically over the month, as shown on the diagram. The line by each date represents 00:00 UT.



THE NIGHT SKY – NOVEMBER

Explore the celestial sphere with our Northern Hemisphere all-sky chart

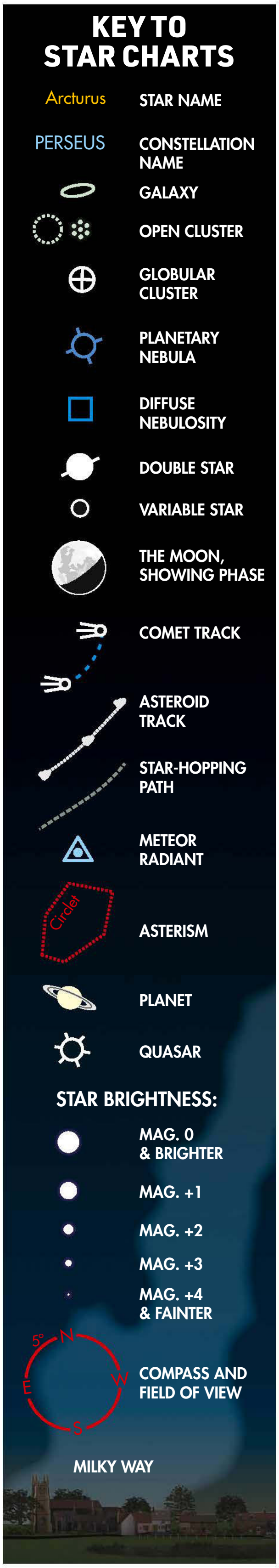

KEY TO STAR CHARTS
Arcturus
STAR NAME
PERSEUS
CONSTELLATION NAME
GALAXY
OPEN CLUSTER
GLOBULAR CLUSTER
PLANETARY NEBULA
DIFFUSE NEBULOSITY
DOUBLE STAR
VARIABLE STAR
THE MOON, SHOWING PHASE
COMET TRACK
ASTEROID TRACK
STAR-HOPPING PATH
METEOR RADIANT
Circlet
ASTERISM
PLANET
QUASAR
STAR BRIGHTNESS:
MAG. 0 & BRIGHTER
MAG. +1
MAG. +2
MAG. +3
MAG. +4 & FAINTER
5°
N
E
W
S
COMPASS AND FIELD OF VIEW
MILKY WAY

CHART: PETE LAWRENCE

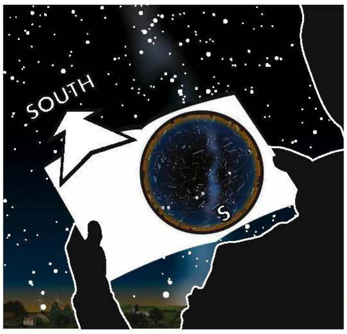
When to use this chart

1 November at 00:00 UT
15 November at 23:00 UT
30 November at 22:00 UT

On other dates, stars will be in slightly different positions because of Earth's orbital motion. Stars that cross the sky will set in the west four minutes earlier each night.

How to use this chart

1. Hold the chart so the direction you're facing is at the bottom.
2. The lower half of the chart shows the sky ahead of you.
3. The centre of the chart is the point directly over your head.



Sunrise/sunset in November*

Date	Sunrise	Sunset
1 Nov 2025	07:09 UT	16:37 UT
11 Nov 2025	07:28 UT	16:19 UT
21 Nov 2025	07:46 UT	16:04 UT
30 Nov 2025	08:01 UT	15:55 UT

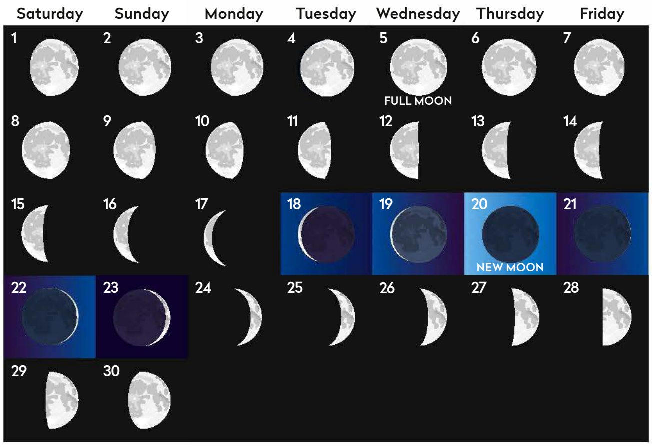
Moonrise in November*

Moonrise times

1 Nov 2025, 15:05 UT
5 Nov 2025, 15:55 UT
9 Nov 2025, 19:20 UT
13 Nov 2025, --:-- UT
17 Nov 2025, 04:41 UT
21 Nov 2025, 09:39 UT
25 Nov 2025, 12:30 UT
29 Nov 2025, 13:20 UT

*Times correct for the centre of the UK

Lunar phases in November


Saturday
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
1
2
3
4
5
FULL MOON
6
7
8
9
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11
12
13
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19
20
NEW MOON
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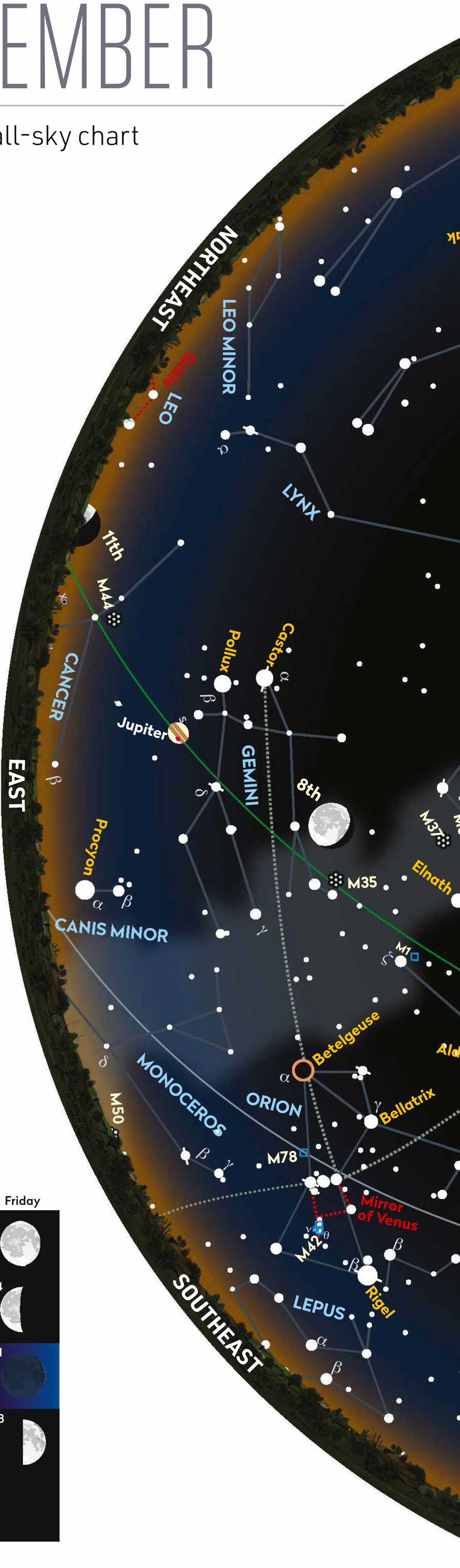
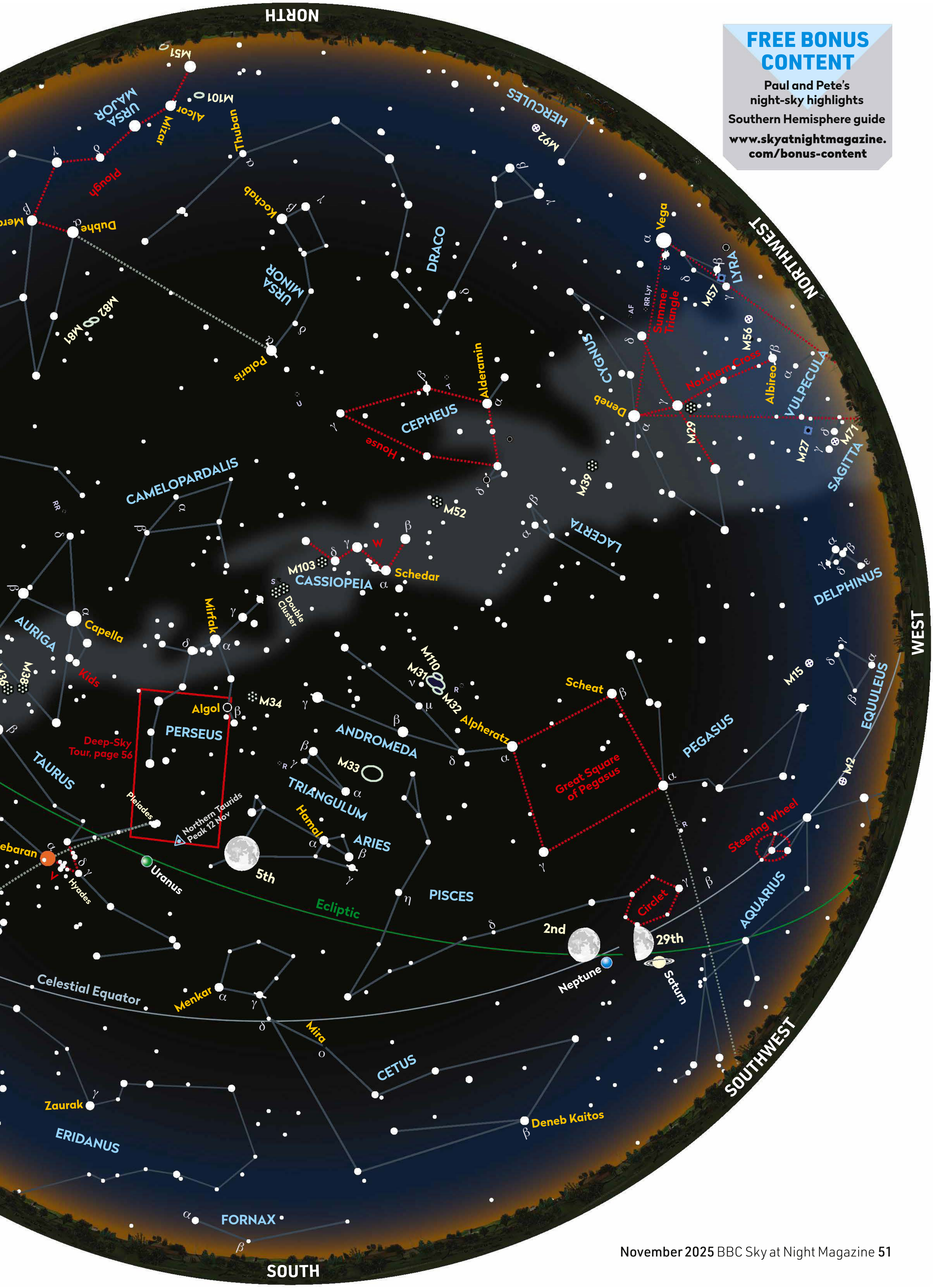
30


NORTHEAST
LEO MINOR
Sickle
LEO
α
LYNX
11th
M44
ε
CANCER
Pollux
Castor
β
α
Jupiter
GEMINI
EAST
β
δ
8th
M37
Elnath
M35
Procyon
α
β
CANIS MINOR
γ
M1
ζ
Betelgeuse
Ald
α
ORION
Bellatrix
γ
MONOCEROS
δ
M50
β
γ
M78
Mirror of Venus
M42
ι
θ
β
β
Rigel
LEPUS
α
β
SOUTHEAST


NORTH
M51
M101
URSA MAJOR
Alcor
Mizar
Thuban
Plough
Dubhe
Mer
Kochab
URSA MINOR
DRACO
HERCULES
M92
M82
M81
Polaris
Vega
LYRA
M57
RR Lyr
Summer Triangle
NORTHWEST
M56
CYGNUS
Northern Cross
Albireo
VULPECULA
Deneb
M29
M27
M71
SAGITTA
Alderamin
CEPHEUS
House
M39
CAMELOPARDALIS
M52
LACERTA
W
Schedar
M103
CASSIOPEIA
Double Cluster
DELPHINUS
Capella
AURIGA
Mirfak
Kids
M38
M110
M31
M32
Alpheratz
Scheat
M15
EQUULEUS
WEST
Algol
M34
PERSEUS
Deep-Sky Tour, page 56
ANDROMEDA
M33
TRIANGULUM
Great Square of Pegasus
PEGASUS
M2
TAURUS
Pleiades
Northern Taurids Peak 12 Nov
Hamal
ARIES
Steering Wheel
ebaran
Hyades
Uranus
5th
PISCES
Ecliptic
Circlet
AQUARIUS
2nd
29th
Neptune
Saturn
Celestial Equator
Menkar
Mira
CETUS
SOUTHWEST
Zaurak
ERIDANUS
Deneb Kaitos
FORNAX
SOUTH

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Paul and Pete's night-sky highlights

Southern Hemisphere guide

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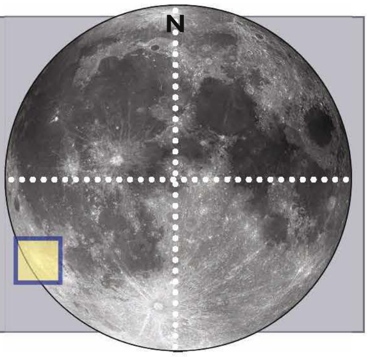
MOONWATCH November's top lunar feature to observe

Byrgius

Type: Crater
Size: 88km
Longitude/latitude: 65.4° W, 24.7° S
Age: Around 3.9 billion years
Best time to see: Five days after first quarter (3 and 4 November) or four days after last quarter (17 and 18 November)
Minimum equipment: 50mm telescope



Crater **Byrgius** is located in a highland region roughly midway between dark-floored **Grimaldi** (222km) and **Schickard** (227km). Under high illumination, this 88km-diameter feature is best revealed by **Byrgius A**, an 18km crater with an impressively bright ray system emanating from it. The rays stand out very well under direct illumination, even against the bright surrounding highlands.

> Byrgius is best revealed by Byrgius A, a crater with an impressively bright ray system

Byrgius A sits on the eastern rim of Byrgius, its rays expanding out in all directions and completely covering Byrgius's floor. Byrgius A is an example of a classic, young crater. Its sharp, round rim is distorted into an ellipse due to foreshortening from Earth's perspective. Internally, its relatively smooth and shallow walls slope for 6km to a 6km-diameter flat floor.

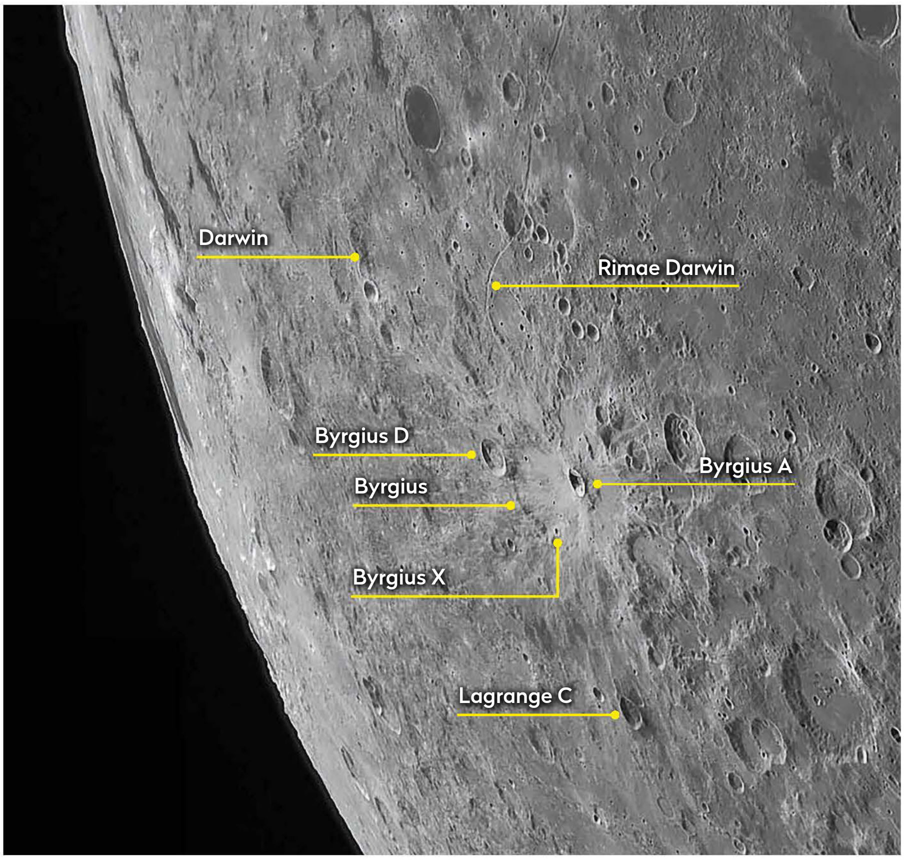
Just outside the northwest boundary of Byrgius is the impressively sharp form of **Byrgius D**, the circular shape of which is foreshortened into a smooth ellipse as seen from Earth. Inside the defined rim, the inner walls slope smoothly down to a flat floor, giving the appearance of a perfect small crater with no signs of damage from impacts or erosion. The outer ramparts of Byrgius D bulge gently, distorting the rim of Byrgius as they go. This of course indicates that Byrgius D is younger than Byrgius.

The main rim of Byrgius is well defined in the east, if you can overlook the interruption of Byrgius A. The sections immediately north and south of Byrgius A reach altitudes just over 2km, towering above Byrgius's floor by nearly 3km; the floor sinks to around 1km below what's considered as 0km altitude. The rim to the west is less impressive, rising to a height of around 1.7km above Byrgius's floor. The section to the northwest, where the ramparts of Byrgius D bulge into Byrgius, is higher, rising to 2.5km above the main crater's floor. Despite its smaller size, Byrgius D is impressively deep: its floor lies around 1km below the average lunar surface and its rim walls rise to about 2.5km above that floor.

The northern half of Byrgius's floor appears relatively featureless save for a small 4km craterlet near the northern boundary and a couple of smaller 2km craterlets in the main area. Under oblique illumination, the southern half of the floor appears somewhat elevated and more rugged, with a small ridge feature arcing east–west along the lower quarter of the crater. The ridge is marked by a small 2.5km craterlet. Finally, near the southern edge is a more substantial 6km craterlet named **Byrgius X**. Byrgius's southern rim section is quite depressed compared to the rest, barely reaching 400 metres in height. South of this is a region filled with lava areas that, although they have crater shapes, appear unidentified as such. The next large feature is 23km **Lagrange C**, located 110km south of Byrgius's southern rim.

Heading north takes you into a complex region where owners of larger instruments might like to look for the extensive rille system known as **Rimae Darwin**. **Darwin** is a 30km walled plain located north-northwest of Byrgius, a feature so battered and eroded by impacts and cracks in the lunar surface that it makes Byrgius look quite fresh!

▼ Big, battered Byrgius is flanked by sharper features, including the bright ray-crater Byrgius A



PETE LAWRENCE X 3

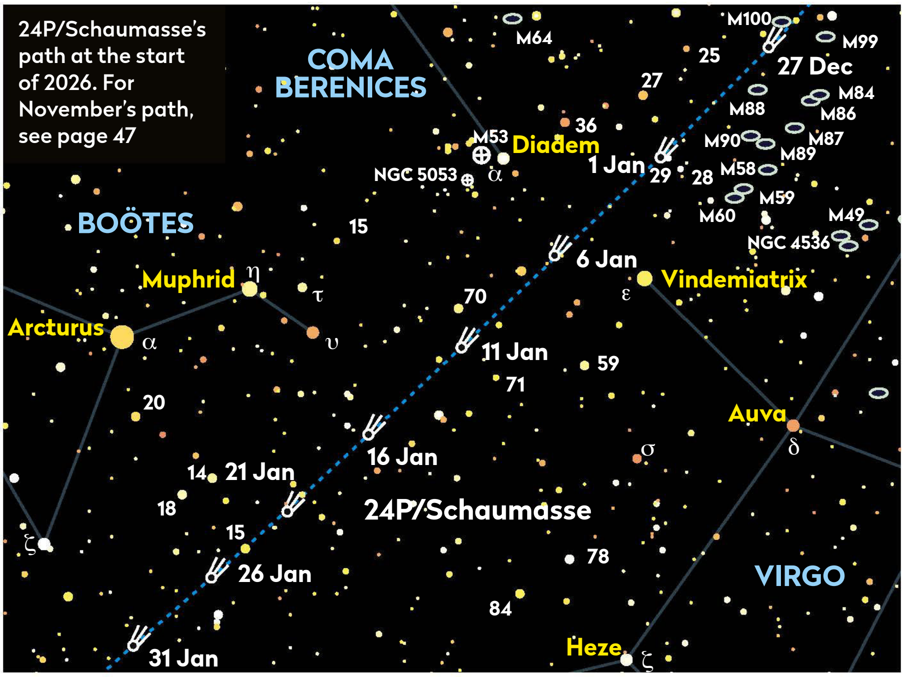
COMETS AND ASTEROIDS

Track comet 24P from the Beehive to Boötes

Comet 24P/Schaumasse, which passes in front of the Beehive Cluster this month (see page 47), was discovered by French astronomer Alexandre Schaumasse on 1 December 1911. It has an orbital period of 8.252 years and will next reach perihelion on 8 January 2026. At that time, it's expected to be around mag. +9.9 (suitable for small telescopes) and crossing from south of Melotte 111 into southern Boötes, where the bright Arcturus (Alpha (α) Boötis) provides a convenient way to locate it.

The comet has a 2.6km nucleus and its orbit stretches from 1.21 AU at perihelion to 9.96 AU at aphelion. During its 1951–52 apparition, 24P/Schaumasse unexpectedly brightened to mag. +6. This, along with missed recoveries in 1968 and 1976, led to speculation that a destructive event caused the brightening. However, 24P was recovered in 1984 and later analysis of a 1976 photograph revealed an object subsequently identified as the comet.

Comet 24P/Schaumasse has had several close encounters with large Solar System bodies, including passes of Jupiter in 1913 and 1937 that slightly altered its orbit. On 4 January 2026, the comet will be at its closest to Earth, passing by at 0.6 AU (90 million kilometres).


24P/Schaumasse's path at the start of 2026. For November's path, see page 47

COMA BERENICES
BOÖTES
VIRGO
24P/Schaumasse
27 Dec
1 Jan
6 Jan
11 Jan
16 Jan
21 Jan
26 Jan
31 Jan
Arcturus
Muphrid
Diadem
Vindemiatrix
Auva
Heze
M64
M53
NGC 5053
M100
M99
M88
M84
M86
M90
M87
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M58
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M49
NGC 4536
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STAR OF THE MONTH

Diphda, the frog in the Whale's mouth

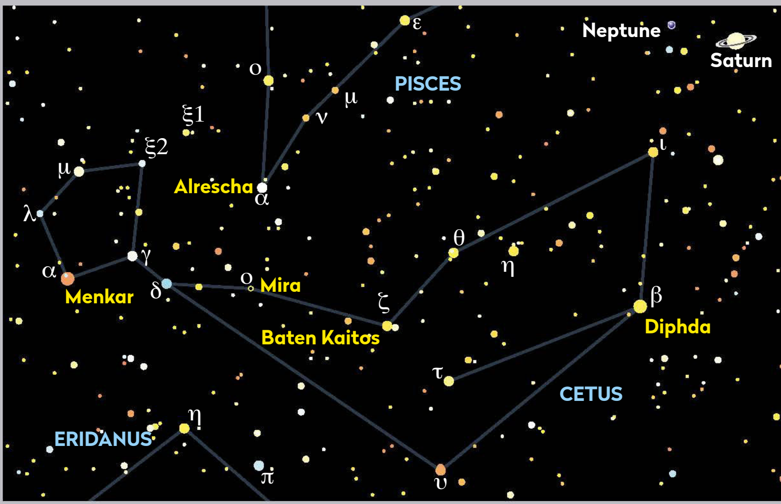
Cetus, the large, sprawling constellation of autumn and early winter skies, is commonly referred to as a whale. Indeed, on charts its outline does resemble a west-facing whale – but this is misleading.

The star marking the 'tail', Menkar (Alpha (α) Ceti), has a name that means 'nostril', while Diphda (Beta (β) Ceti), the supposed 'mouth', actually means 'second frog' (the 'first frog' being Fomalhaut, the brightest star in Piscis Austrinus). An earlier name for Diphda was Deneb Kaitos, meaning 'whale's tail', which seems more fitting… except it conflicts with the idea of the whale facing west.

Diphda shines at mag. +2.0, making it brighter than Menkar's mag. +2.5. It's an orange giant of spectral type K0 III, located 96.3 lightyears from the Sun. The star is 17.5 times larger than the Sun and has 3.5 times its mass. Despite the relative obscurity of Cetus, Diphda is very easy to locate thanks to the Great Square of Pegasus. Extend the line of the Great Square's eastern side southwards and you'll eventually arrive at Diphda.

Astronomers don't fully understand what's going on with Diphda. It's a bright X-ray source, one of the brightest close to the Sun, typically expected from a magnetically heated corona driven by rotation. However, Diphda rotates at just 18km/s. Its X-ray output also suggests a star just having left the main sequence, but spectral analysis suggests it's more evolved. Diphda also shows increased luminosity from flaring that lasts for several days. In contrast, our Sun's flaring tends to last just hours.

▼ Diphda (Beta (β) Ceti) looks like the Whale's mouth, but its name translates as 'second frog'


PISCES
CETUS
ERIDANUS
Neptune
Saturn
Alrescha
Menkar
Mira
Baten Kaitos
Diphda
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ξ1
ξ2
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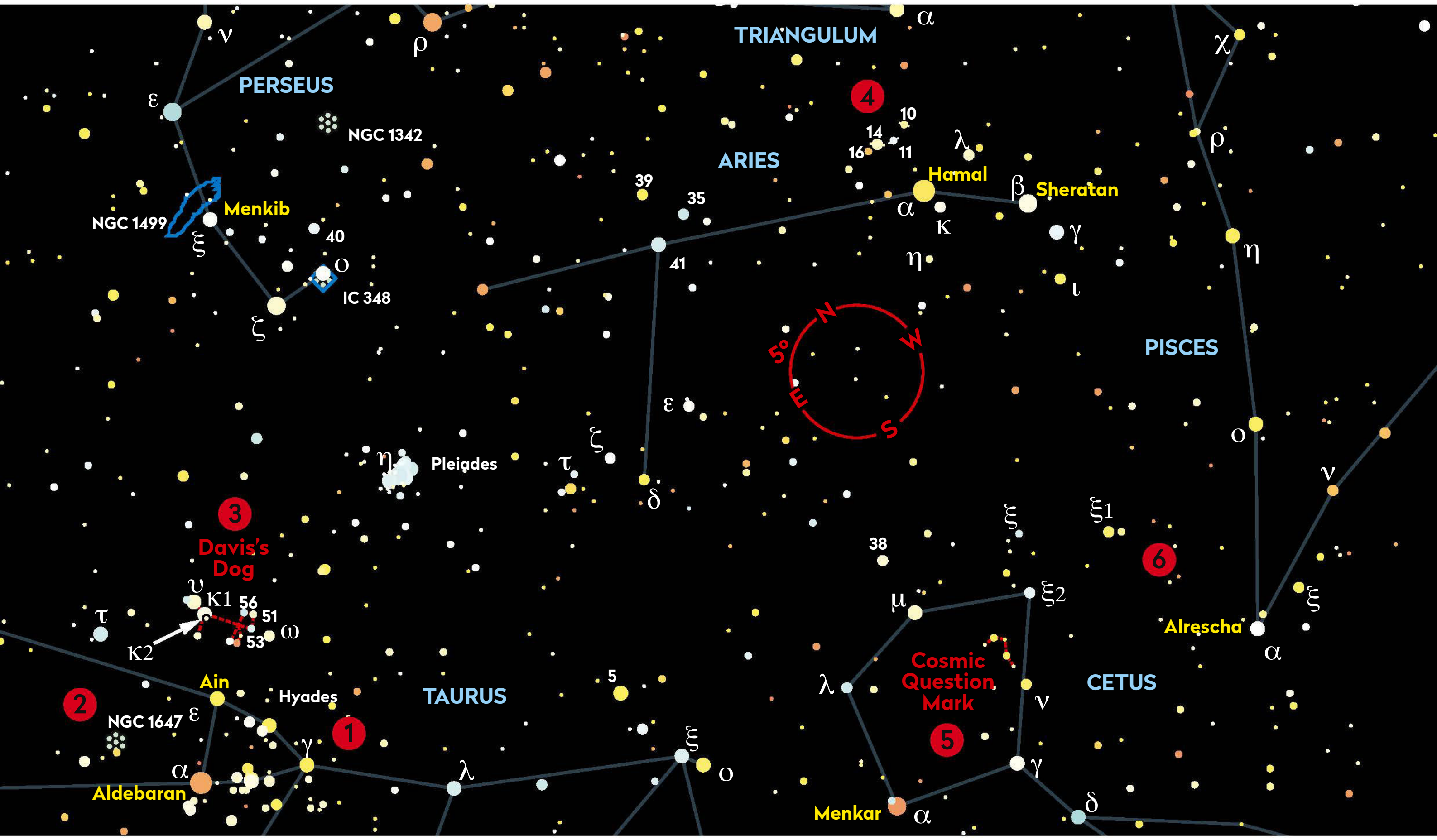
BINOCULAR TOUR

With Steve Tonkin

Chase a stellar beagle, ponder a cosmic question and take on our Xi scavenger hunt



1. The Hyades

10x50 The V-shaped Hyades open star cluster is next to mag. +1.0 Aldebaran (Alpha (α) Tauri), the reddish eye of the Bull, a foreground star that's not actually part of the cluster. At 153 lightyears distant, it's the nearest open cluster to Earth. In British folklore, the Hyades are the "8 for the April Rainers" in the counting song *Green Grow the Rushes, O*, referring to spring rains at their final dawn appearance. ☐ **SEEN IT**

2. NGC 1647

10x50 Just 3° northeast of Aldebaran is a delightful little open cluster, NGC 1647. It's often overlooked because of the presence of its more prominent neighbour. With 10x50 binoculars, you should be able to see eight or nine stars against a background glow a bit bigger than the apparent size of the Moon. Although it's twice the size of the Hyades, it appears small in comparison because it's nearly 12 times farther away. ☐ **SEEN IT**

3. Davis's Dog

10x50 The late Massachusetts astronomer John Davis, who discovered this asterism, saw it as a cosmic beagle. You'll find it 2.5° northwest of mag. +3.5 Ain (Epsilon (ε) Tauri), covering a region of about 3.5° by 1.5°. Three of the brighter stars, 51, 53 and 56 Tauri, form its head; a string of four, including the wide double star mag. +4.2 and +5.1 Kappa^1 (κ^1) and Kappa^2 (κ^2) Tauri, make its tail.

☐ **SEEN IT**

4. 10, 11 and 14 Arietis

10x50 If you look 2.5° north of mag. +2.0 Hamal (Alpha (α) Arietis), you'll see three pairs of stars in the same field of view. The yellowish components of 10 Arietis are mag. +5.7 and +7.1, separated by 9.5 arcminutes, whereas those of 11 Arietis are +6.0 and +7.3, 7.7 arcminutes apart and distinctly white. The yellow-white components of 14 Arietis are mag. +5.0 and +7.9 and much closer, at 108 arcseconds. ☐ **SEEN IT**

5. The Cosmic Question Mark

10x50 Use the chart to identify mag. +4.9 Nu (ν) Ceti and hold it at the bottom half of your field of view. You'll see that it's the point at the bottom of the 2.25°-long question mark asterism. This is a good star-party object, both because of its shape and the varied colours of the sixth- and seventh-magnitude stars that make up the asterism. ☐ **SEEN IT**

6. A fortuitous Xi group

10x50 There are four stars with the Bayer designation Xi (ξ) in this region of sky, each with a different colour. Mag. +5.5 Xi Arietis is bluish white, mag. +4.3 Xi^2 Ceti is pure white, mag. +4.4 Xi^1 Ceti is distinctly yellowish and mag. +4.6 Xi Piscium is yellow-orange. There are also fainter yellow-white and orange-red stars in the region. Can you find them? (It helps to defocus slightly to reveal the colours.)

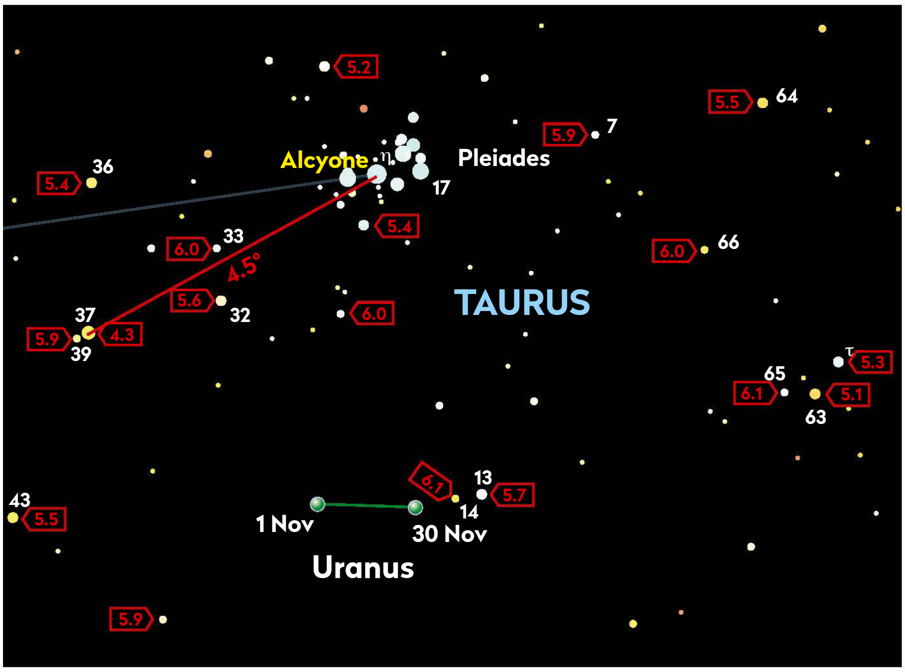
☐ **SEEN IT**

☑ Tick the box when you've seen each one

PETE LAWRENCE X 3

THE SKY GUIDE CHALLENGE

Can you spot Uranus with your naked eye? This 'stepping star' technique will help



▲ **Magnitude 'stepping stars' near Uranus. We'd suggest trying to find 37 Tauri, then 63, Tau (τ), 36, 43 and 32. If you achieve this, you should be all set for locating Uranus**

How many times have you heard that Uranus can be seen with the naked eye? We've certainly mentioned it often, but have you actually tried it? Chances are you haven't, and even if you have, you may have run into a number of common problems, such as not having a dark enough sky, not knowing exactly where to look or being fooled by nearby stars that have a similar brightness. All in all, it's enough to make you want to give up – but we'd urge you to keep at it, as Uranus is currently at mag. +5.6 and in a part of the sky that makes it relatively easy to locate.

Let's start there: Uranus is now due south of the Pleiades open cluster, M45. It's easy to find, even with moderate light pollution. To locate Uranus, look 4.4° south of the cluster. Simple? Not quite. For one thing, how far is 4.4°?

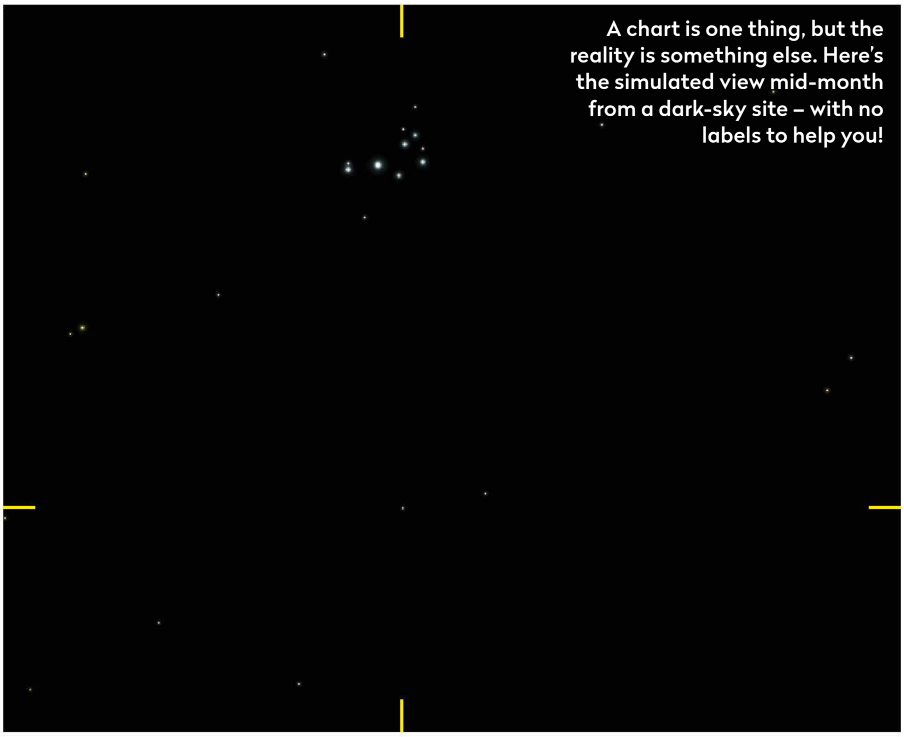
Find a reference star

Conveniently, there's a star that will help you out here. 37 Tauri is located 4.5° to the east-southeast of Alcyone (Eta (η) Tauri), the brightest star in the Pleiades cluster. 37 Tauri shines at magnitude +4.3, which makes it a fairly straightforward naked-eye target and one which, if not visible to you, acts as a warning that you won't be able to see Uranus anyway!

Assuming you can spot 37 Tauri, all you need to do is look south of the Pleiades for roughly the same distance as between 37 Tauri and Alcyone. However, unless your sky is very dark, it's probable that you still may not see Uranus. If this is the case, the next step is to work out by how much you're missing it. We've marked some 'stepping stars' to assist you. Simply work your way along them to determine where your brightness threshold is. If you're only just missing the mark, then try moving somewhere a little darker to make another attempt.

> ***"Simply work your way along these stars to determine where your brightness threshold is"***

If you're off by a magnitude or more, you'll have to work a little harder to find a truly dark site. To maximise your chances, make sure it's somewhere with no direct views of bright lights. You'll need at least 20 minutes in complete darkness for your eyes to properly dark adapt too. If you're still struggling and Uranus won't reveal itself, try the technique of averted vision: looking slightly to the side of a faint object so that its light falls on a more sensitive part of your retina.



A chart is one thing, but the reality is something else. Here's the simulated view mid-month from a dark-sky site – with no labels to help you!

DEEP-SKY TOUR

Darker nights are perfect for misty sights: discover these nebulous gems near Perseus

1 IC 351

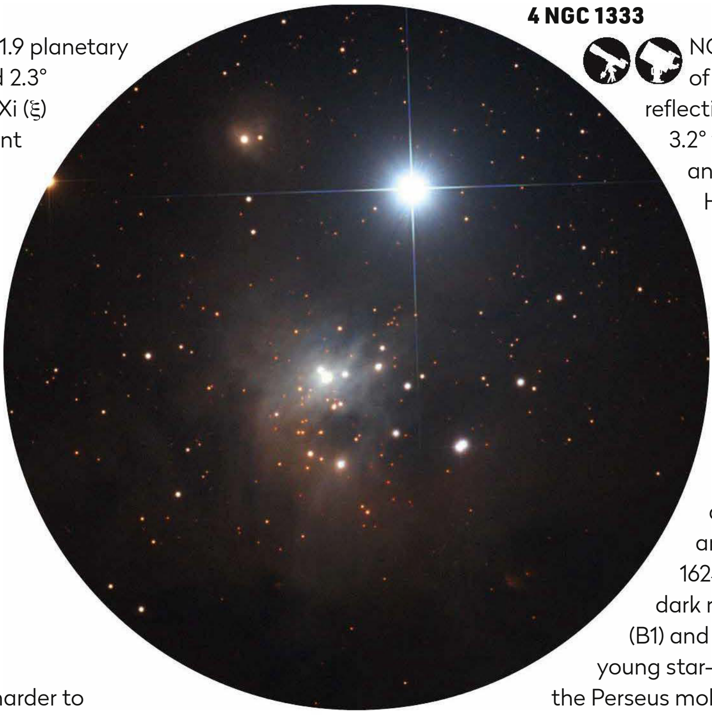
First up is the mag. +11.9 planetary nebula IC 351, located 2.3° west and 0.8° south of Menkib (Xi (ξ) Persei). Despite its small apparent size – just 8 x 6 arcminutes – it's visible through a small scope, a 150mm instrument showing a star-like appearance at low powers. Magnifications above x200 show it as an extended object, while larger scopes tend to reveal it as a blue-hued, blurry star. Two small, bright patches lie on the periphery of the main disc, but require a modest aperture and high power to see. The central star is around 15th magnitude. ☐ **SEEN IT**

2 IC 2003

If anything, it's even harder to extract detail from our next planetary nebula, IC 2003. One point in its favour is that it's easy to locate manually. Simply identify mag. +4.0 Menkib and mag. +2.8 Zeta (ζ) Persei: IC 2003 sits conveniently at the mid-point between them. It has a visual magnitude of +11.4 and an apparent size of around 7 arcseconds across. At powers below x280 it's easily mistaken for a star. Its proximity to IC 351 gives you the opportunity to compare and contrast the two. Interestingly, despite the catalogued sizes being very similar, the visual experience seems to suggest that IC 351 is the larger object. ☐ **SEEN IT**

3 IC 348

Reflection nebula IC 348 is even easier to locate as it sits very near mag. +3.8 Atik (Omicron (ο) Persei). This star is actually a blessing and a curse: it makes finding the mag. +7.3 nebula simple, but it's so close that its glare makes IC 348 difficult to see. As a result, despite its tantalisingly bright magnitude listing, IC 348 can be challenging to see well. The nebula is associated with a 2-million-year-old cluster, the most massive members being the binary star system HD 281159. This prominent marker will guide you to the nebula, the delicate glow of which surrounds this star. Aim to keep this star in view but put Atik out of the field. ☐ **SEEN IT**



▲ Atik's brilliance leads you to reflection nebula IC 348 – but its glare will be a nuisance

4 NGC 1333

NGC 1333 is another region of diffuse nebulosity. This reflection nebula lies 1.0° south and 3.2° west of Atik and shines with an integrated magnitude of +5.6. However, its light is spread over 9 x 7 arcminutes, so its surface brightness is low. A 150mm scope shows an elongated glow around a mag. +10.5 star, HIP 16243. Larger apertures deliver more structure – a brighter region to the southwest of HIP 16243 and a circular patch encircling a 12th-magnitude star 10 arcminutes northeast of HIP 16243. The nebula contains two dark regions, designated Barnard 1 (B1) and Barnard 2 (B2). This object is a young star-forming region on the edge of the Perseus molecular cloud. ☐ **SEEN IT**

5 NGC 1514

For our penultimate target, you'll need to slew 8.5° to the east, dipping 0.5° to the south as you go. This will slip you across the border from Perseus and into Taurus. Here lies the planetary nebula NGC 1514. This object has a listed magnitude of +10.9 and a size of 2.3 x 2.0 arcminutes. However, it's the central star HD 281679 which is key here, as it shines at a bright mag. +9.4 and is easy to find with a small scope. Locate the central star with a 150mm scope and the nebula can be detected by averted vision as a gentle glow or haze around the star, about 1 arcminute across. Larger scopes show the glow with direct vision and it becomes apparent that the nebula is not uniformly lit. NGC 1514 also goes by the informal name of the Crystal Ball Nebula. ☐ **SEEN IT**

6 M45

Our last object needs no introduction and, unlike our previous targets, is easy to see with just the naked eye. M45, the Pleiades, is a magnificent young open cluster with many stars that are visible to small telescopes. One issue is its size, as higher powers look right through it. A reflection nebula winds its way around the brighter stars and can be glimpsed under darker skies, especially near the stars Merope and Maia. Another standout feature is the bent line of mag. +7 and +8 stars to the southeast of the main pattern. Known as Ally's Braid after the brightest star Alcyone (Eta (η) Tauri), it's easy to spot through any instrument. The Pleiades are 444 lightyears away and around 2° across. It's estimated to be 75–150 million years old. ☐ **SEEN IT**

This Deep-Sky Tour has been automated

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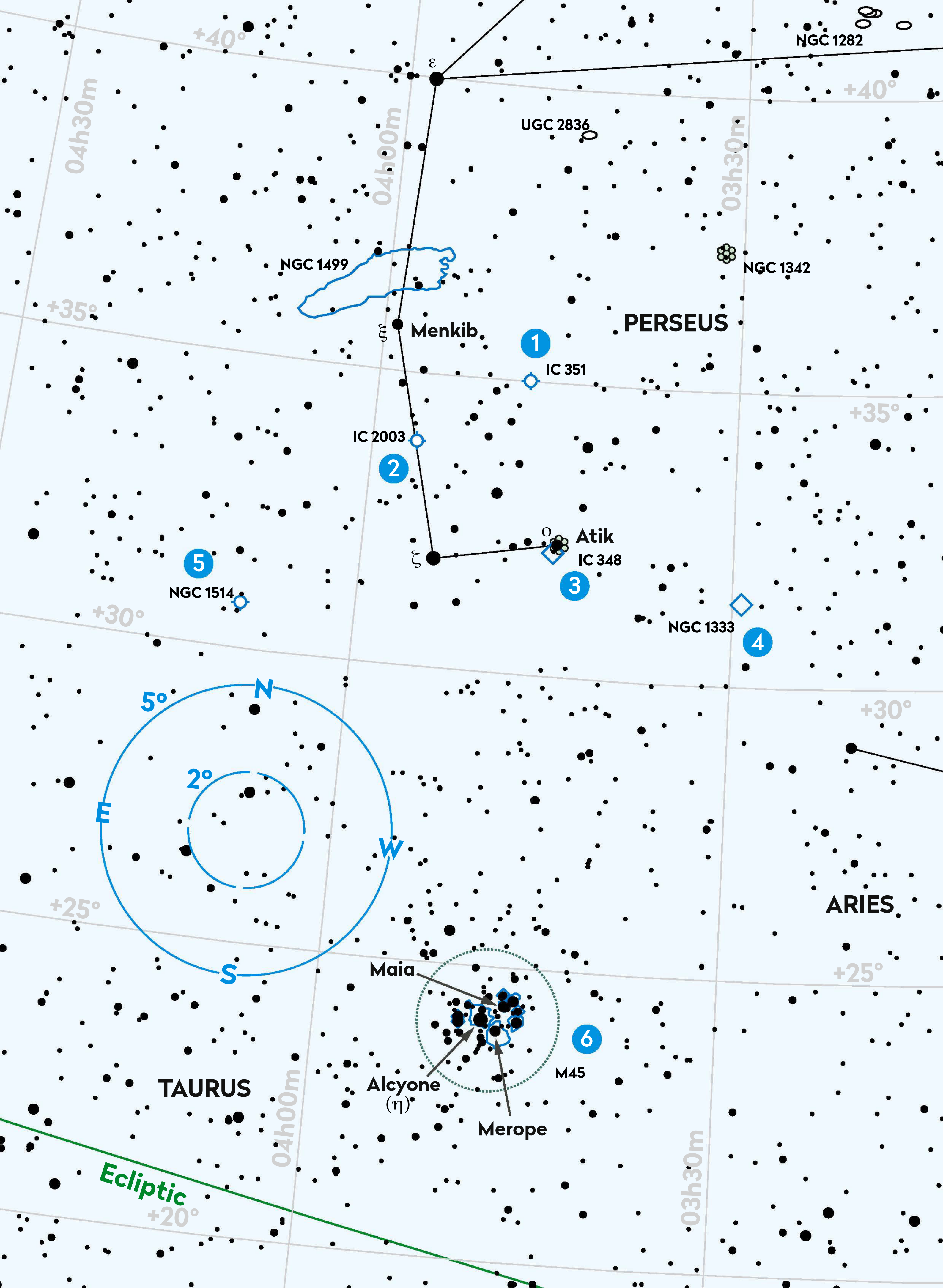
+40°
ε
NGC 1282
+40°
UGC 2836
04h30m
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NGC 1499
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IC 351
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6
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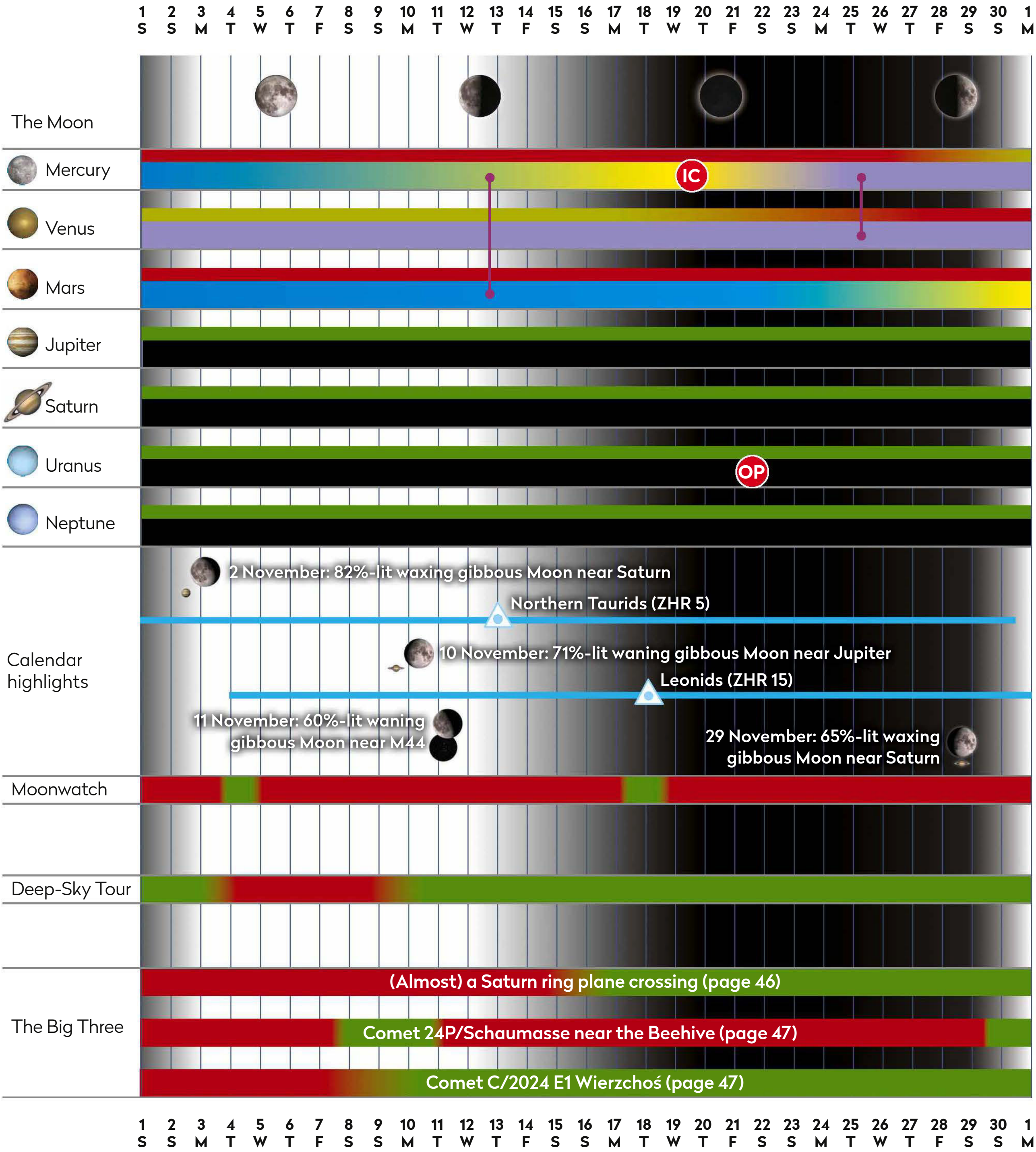
AT A GLANCE

How the Sky Guide events will appear in November



KEY

Observability

🟩 Optimal
🟥 Poor

Best viewed

Morning twilight
Daytime
Evening twilight
Night

Sky brightness during lunar phases

Dark (first quarter)
Light (full Moon)
Dark (last quarter)
Total darkness (new Moon)

IC Inferior conjunction (Mercury & Venus only)
SC Superior conjunction
OP Planet at opposition
△ Meteor radiant peak
Planets in conjunction

Full Moon
First quarter
Last quarter
New Moon

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Cosmology says space is evenly spread and the same in every direction – but we may need to rethink everything we thought we knew

Is the Universe uniform?

One of astronomy's most fundamental assumptions may be wrong. **Colin Stuart** investigates whether our belief that the Universe looks the same everywhere holds up to scrutiny

Imagine you're in a woodland, with sunlight filtering through the endless green canopy overhead. There's uniqueness everywhere. Some trees grow bolt upright, but others are wizened and twisted. Here the ground is clear, but over there it's riddled with brambles and thorns.

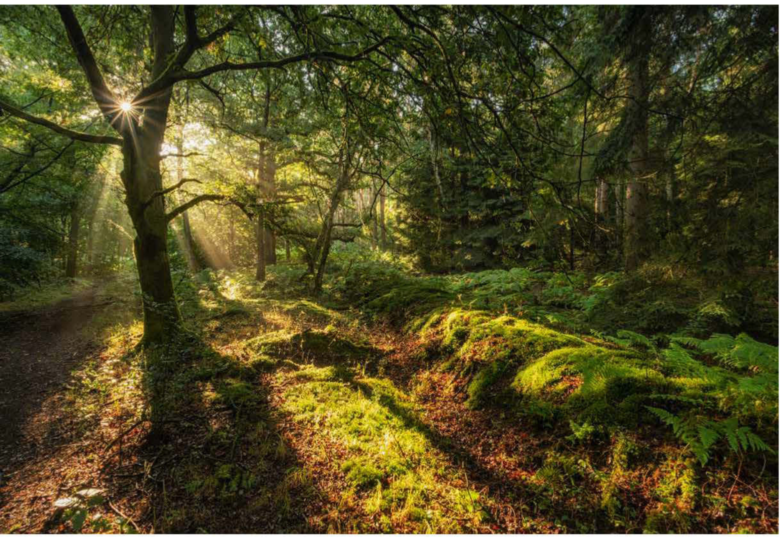
Yet this individuality fades if you can climb a ridge and lift yourself above the canopy. Now your view is a constant sea of green for as far as the eye can see. The forest is both regular and directionless.

Most cosmologists believe that the Universe works in the same way. At small scales, there are individual quirks such as stars, planets and different types of galaxies. But zoom out far enough, to scales of hundreds of millions of lightyears, and it's like climbing that ridge: the Universe becomes uniform.

Astronomers say that, on large scales, the Universe is both homogeneous and isotropic. Homogeneous means the Universe is the same everywhere – drop into any sufficiently large patch of space and, on average, you'd see the same spread of galaxies. Isotropic means the Universe looks the same in every direction – no matter whether you look north, south, east or west, the broad brushstrokes of the cosmic picture repeat.

Together, these ideas underpin an almost sacrosanct astronomical assumption that's known as the ▶

ILLUSTRATION: MARK GARLICK, SCIENCE PHOTO LIBRARY, ALAMY



▲ **Up-close individuality, zoomed-out homogeneity: like forests seen from above, the Universe appears uniform when viewed across vast distances**

▶ cosmological principle, which says that we do not occupy a special place in the Universe.

"Homogeneity and isotropy are absolutely central to modern cosmology," says Blake Sherwin, a professor of cosmology at the University of Cambridge. "If we ever robustly confirmed a departure from them, it would force us to reexamine the foundations of the field."

But the idea is much older than modern cosmology. In the 16th century, Nicolaus Copernicus displaced Earth from the centre of the cosmos, demoting it to just one planet orbiting the Sun. Over time, this insight broadened into the Copernican principle: no location in the Universe is special.

From Bang to balance?

When Isaac Newton used gravity to explain why planets orbit the Sun, he also imagined a Universe filled uniformly with matter. Only such an even distribution, he argued, could prevent gravity from pulling everything into a single catastrophic collapse.

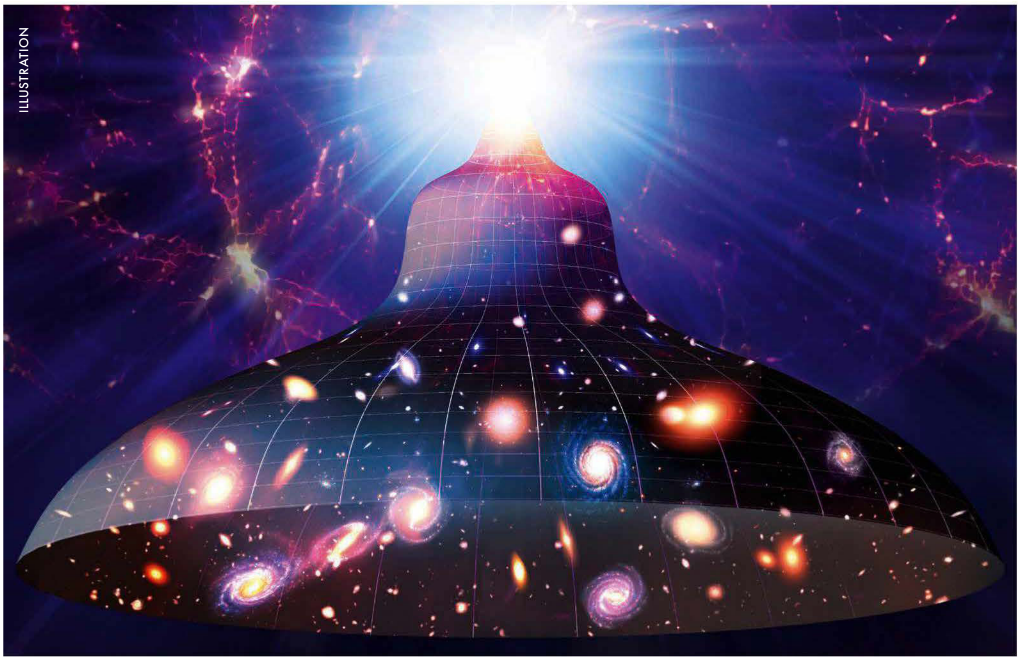
By the 20th century, Einstein's general theory of relativity had replaced Newton's ideas as our best description of gravity. Applying it to the entire Universe was daunting, but assuming the cosmos was homogeneous and isotropic made the task manageable. In doing so, Alexander Friedmann and Georges Lemaître reached a surprising conclusion: a perfectly static Universe was impossible. Instead, the cosmos must be either expanding or contracting.

Einstein himself was reluctant to accept this and tried to force his equations back into a steady solution. But in 1929, Edwin Hubble showed that the Universe is indeed expanding, by proving that galaxies are moving away from us. Lemaître went further, suggesting this expansion must trace back to an initial explosive moment – what we now call the Big Bang.

One of the biggest pieces of evidence for the Big Bang is the cosmic microwave background (CMB). It's the leftover light from the hot, dense birth of the Universe, released when it was just 380,000 years old. In turn, the CMB is also an excellent laboratory for testing the twin ideas of homogeneity and isotropy.

"The cosmic microwave background is remarkably uniform in its physical properties," explains Dr David Lagattuta from Durham University. Its temperature is almost identical throughout, with tiny variations of just one part in 100,000. This is the result of a period in the Universe's first slivers of a second, known as cosmic inflation, during which the nascent cosmos ballooned in size by a factor of 1 followed by 78 zeroes.

And yet, there are hints of more complicated patterns in that early signal.



▼ **The expanding Universe, from the Big Bang and the first galaxies to the present day**

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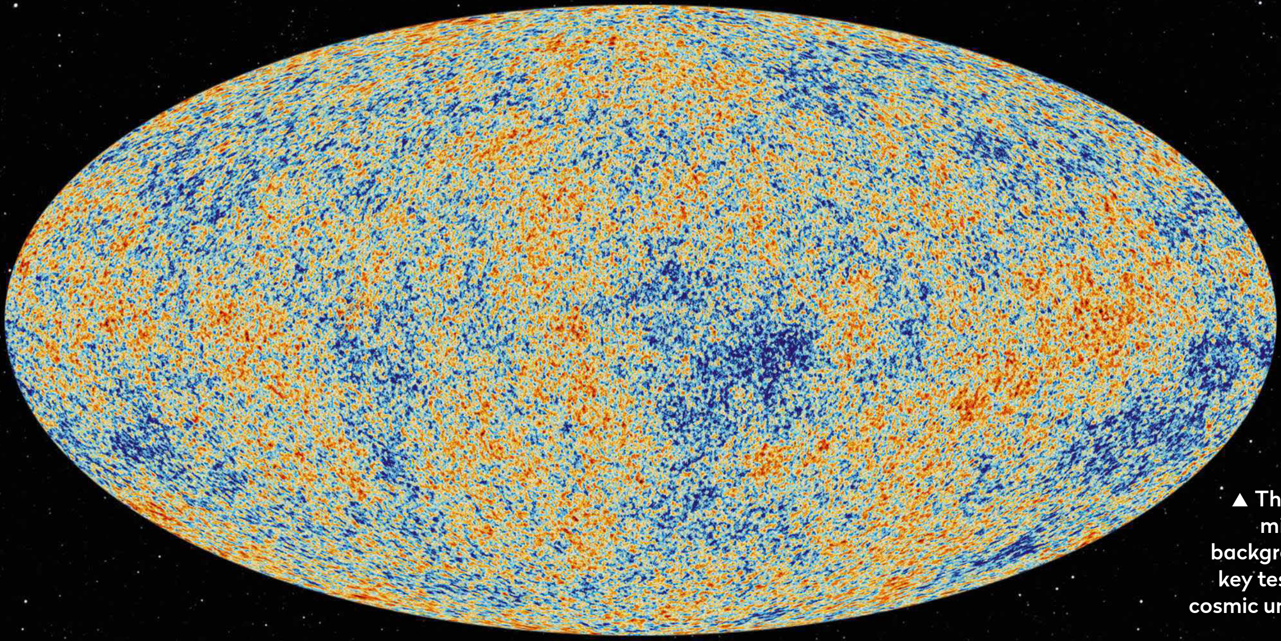
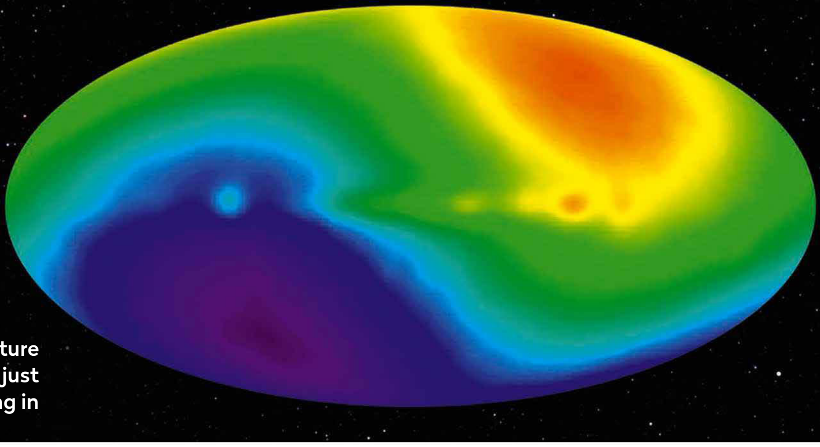


▲ The cosmic microwave background is a key testbed for cosmic uniformity

"There are anomalies in the CMB – one side of the sky looks slightly warmer, the opposite side slightly cooler"



▶ The CMB dipole: but the temperature variation isn't a true break in uniformity – it just looks hotter in the direction we're moving in

Could dark energy be an illusion?

Dr David Lagattuta from Durham University's Centre for Extragalactic Astronomy on how breaking the cosmological principle could upend our ideas about dark energy

If future evidence shows that homogeneity or isotropy don't hold, what would the consequences be for how we view the Universe?
In our current view, about 70 per cent of the Universe is this really mysterious dark energy. We know almost nothing about it. We don't know what it's made of or how it behaves, except it seems to make the Universe expand and accelerate.

But if the cosmological principle – that the Universe is homogeneous (the same everywhere) and isotropic (the same in every direction) – breaks, then the Universe is moving in a different way from what we expected. And that motion can give rise to what we call dark energy. So suddenly this thing we thought we knew nothing about could just be an artefact of the system used to obtain and analyse the data.

What does that mean for the long-term future of the Universe?
With dark energy, the Universe keeps expanding and accelerating. Eventually everything around us moves farther and farther away. At some point, they'll be moving away so fast that we'll never be able to reach them. We'd be isolated in our own little pocket of the Universe.

But if dark energy isn't real – just an effect of inhomogeneity – then maybe things won't keep getting farther away forever. Maybe they'll stop – and then, over billions or trillions of years, we could go out and explore even farther than we can now.

"There are some anomalies in the CMB," says Lagattuta. "One side of the sky looks slightly warmer, the opposite side slightly cooler." This effect is known as the CMB dipole. At first it might look like a violation of isotropy, but in fact it's simply due to motion. As the Solar System ploughs through space, the part of the CMB that we're moving towards appears hotter, while the part we're moving away from looks cooler.

Beyond that, some astronomers have claimed to see subtler effects – quadrupoles and octopoles – in the CMB data. "Interestingly, those differences seem to be aligned with our Solar System," says Lagattuta. "If we assume that there's no unique orientation, why is it that those differences seem to be pointing in the same direction?"

They could simply be the result of some unrecognised contamination from our own Galaxy. But if the alignments are real, they would break isotropy. "It would be quite exciting if it turned out to be real, that there's some difference in physics that we don't understand," comments Lagattuta. For now, it remains an open question.

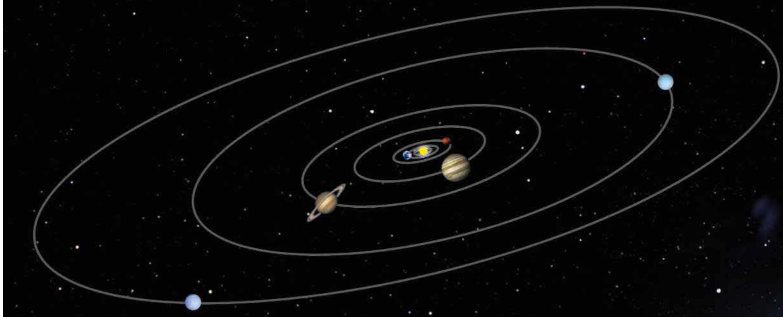
Cosmic clumps and gaps

If the CMB is the cleanest test of isotropy, then the large-scale distribution of galaxies is the toughest test of homogeneity. There is a hierarchy of structure in the Universe. Individual galaxies sit inside clusters, which in turn amass into superclusters. Superclusters are separated by barren wildernesses known as ▶

Sizing up the cosmos

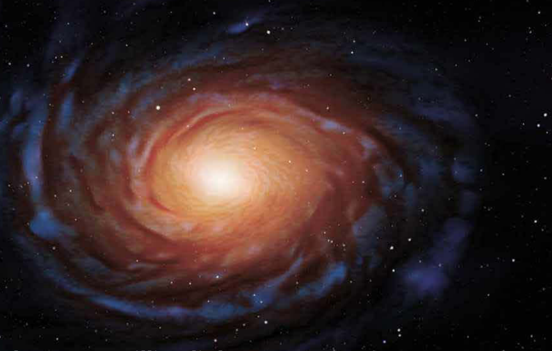
The hierarchy of the Universe, from local neighbourhoods to the largest superclusters

ILLUSTRATION



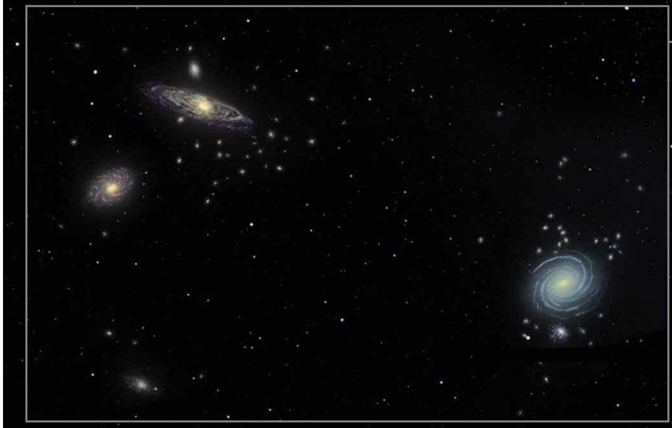
Solar System: 1 lightyear

The Solar System is more than just the eight planets. Its outermost region, the Oort cloud – a giant swarm of comets – stretches a quarter of the way to the next star. That's 100,000 times the distance of Earth's orbit around the Sun.



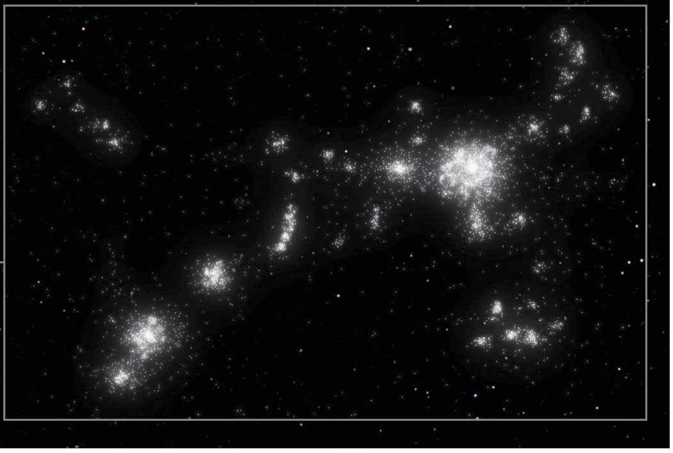
Galaxy: 100,000 lightyears

Our Milky Way is a barred spiral galaxy containing between 200 and 400 billion stars, including the Sun, in a disc that's at least 100,000 lightyears across. But our Galaxy could be as much as 150,000 lightyears wide. Those stars all orbit a central supermassive black hole called Sagittarius A*.



Galaxy cluster: 10 million lightyears

The Milky Way belongs to a small collection of galaxies called the Local Group, which also contains the Andromeda Galaxy and a few hundred smaller galaxies. Size-wise, it overlaps with a small cluster. Much larger galaxy clusters, like the Virgo Cluster, contain at least 1,500 galaxies.



Supercluster: 250–500 million lightyears

The Local Group is part of the Laniakea Supercluster, which is about 520 million lightyears wide and contains 100,000 individual galaxies. Its name means 'immense heaven' in Hawaiian. Laniakea is just one of an estimated 10 million superclusters in the observable Universe.

> ***"On the scale of superclusters and supervoids, everything should blur into sameness... Except that rule doesn't always hold"***

▶ cosmic supervoids. It's on the scale of superclusters and supervoids – around 500 million lightyears – that the Universe is expected to start losing its personality. Like the canopy of trees in the forest, everything should blur into sameness.

Except that rule doesn't always hold. Astronomers made headlines in 2021 with the discovery of an enormous crescent structure known as the Giant Arc. It sits some 9.2 billion lightyears away, but its sheer size is what stands out: nearly 3.3 billion lightyears across, several times larger than the scale at which structures are supposed to fade into uniformity. The research team, led by Alexia Lopez from the University of Central Lancashire, put the chance of it being a mere alignment of unrelated objects at just 0.0003 per cent.

Then, in 2024, the same team claimed the discovery of another giant cosmic structure.

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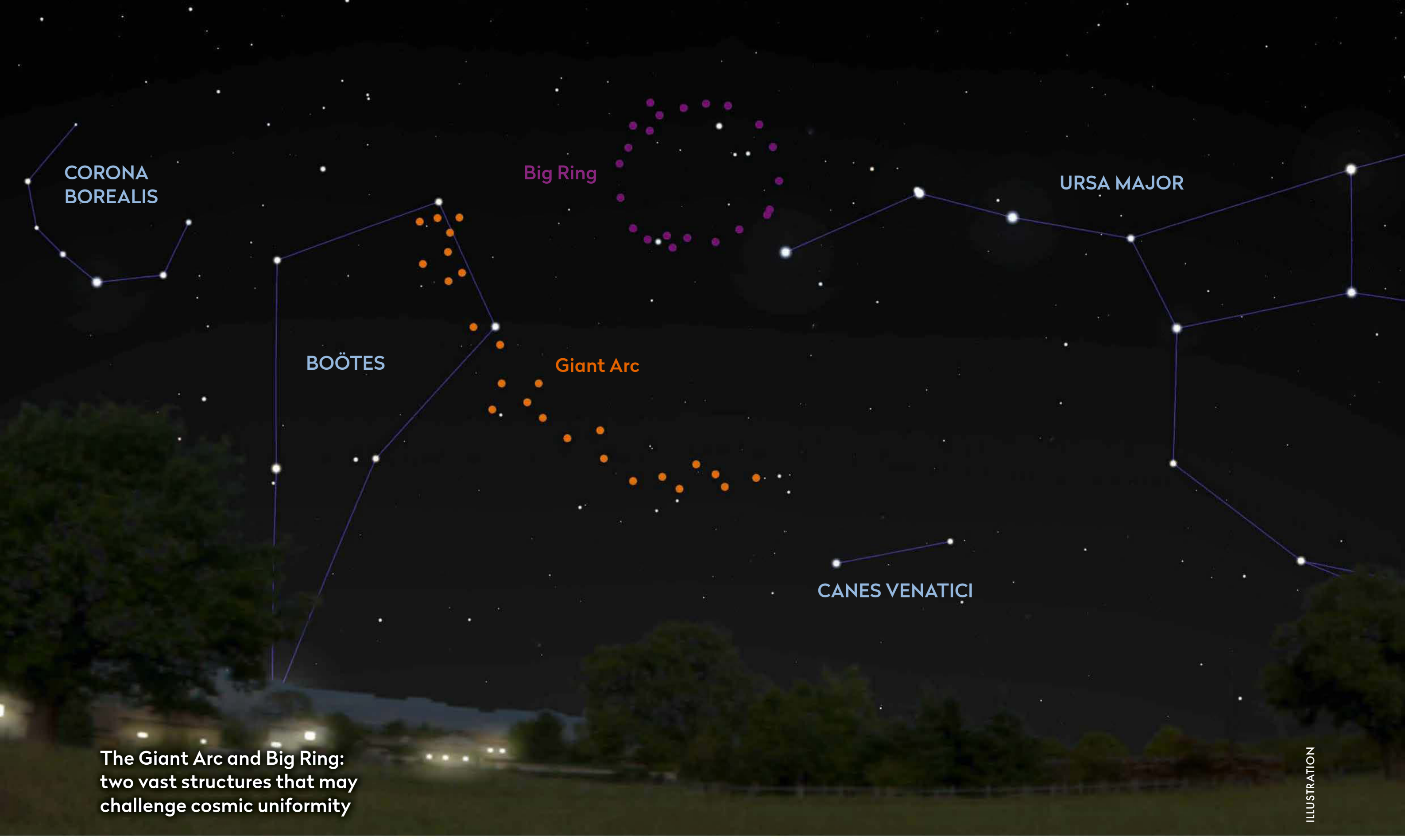
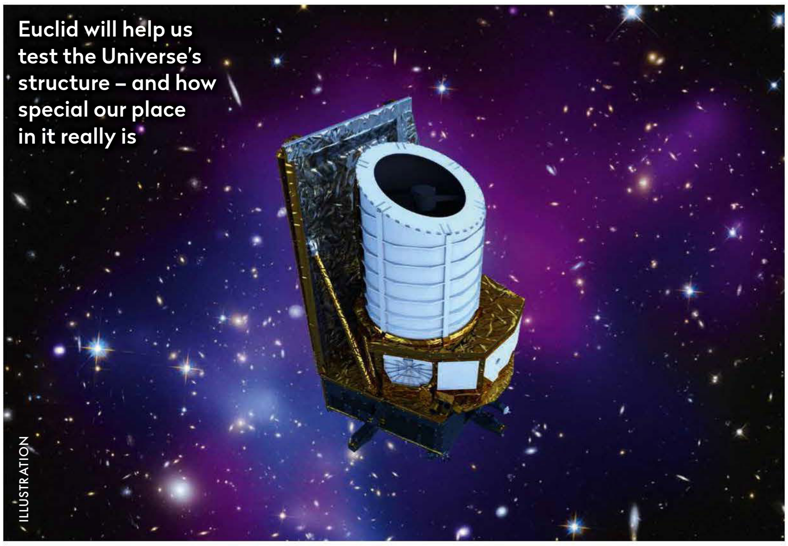


The Giant Arc and Big Ring: two vast structures that may challenge cosmic uniformity



Euclid will help us test the Universe's structure – and how special our place in it really is

Known as the Big Ring, it's a circle of galaxy clusters measuring 1.3 billion lightyears in diameter. Remarkably, both the Giant Arc and the Big Ring are located at roughly the same distance from Earth. They also appear in a similar part of the sky, just 12° apart (the whole sky spans 360°).

Are we in a weird spot?

The Universe is meant to be homogeneous. Drop yourself into any part of it and above a certain scale it should look the same. Yet if these two structures are real, there's clearly something unique about this particular spot.

But some cosmologists aren't ready to get rid of homogeneity and isotropy just yet. "Personally, I think there's a high bar for throwing away these foundational principles," says Blake Sherwin. "If we could, it would be the most interesting thing ever. But the evidence we have so far isn't enough."

Some, like astroparticle physicist and cosmologist Professor Subir Sarkar at the University of Oxford, argue that what we attribute to dark energy could instead be an illusion caused by the inhomogeneity of enormous structures such as the Giant Arc and Big Ring. Dark energy is the mysterious entity thought to be driving the accelerating expansion of the Universe. Astronomers don't know what it is, but it seems to be a property of space itself, expanding the cosmos uniformly and preserving its large-scale smoothness. At least that's the mainstream view.

There are even more radical ideas. The Timescape theory suggests that we live in an overly dense part of the Universe and that's biasing our measurements. Gravity affects the rate at which time passes, so regions with different masses would expand at different rates. If we're observing the cosmos from inside a dense patch, the clock we use to measure the Universe's expansion may not be representative of the cosmos as a whole. In this view, dark energy could again be a figment of our imagination.

One recent alternative – and still controversial – view is that the Milky Way is at the centre of a giant void approximately a billion lightyears in radius. Researchers at the University of Portsmouth have proposed that this may be causing the cosmos to expand faster in our local environment than in other parts.

Right now, it's hard to say for sure – as always, we need more data. The Simons Observatory and the South Pole Telescope will continue to probe the CMB for anisotropies (non-uniform variations). Huge sky surveys, such as Euclid and the Vera Rubin Observatory, are also in the pipeline to map the large-scale structure of the Universe.

But in the end, it all comes down to one question: how special are we, really?

Colin Stuart (@skyponderer) is an astronomy author and speaker. Get a free e-book at colinstuart.net/ebook

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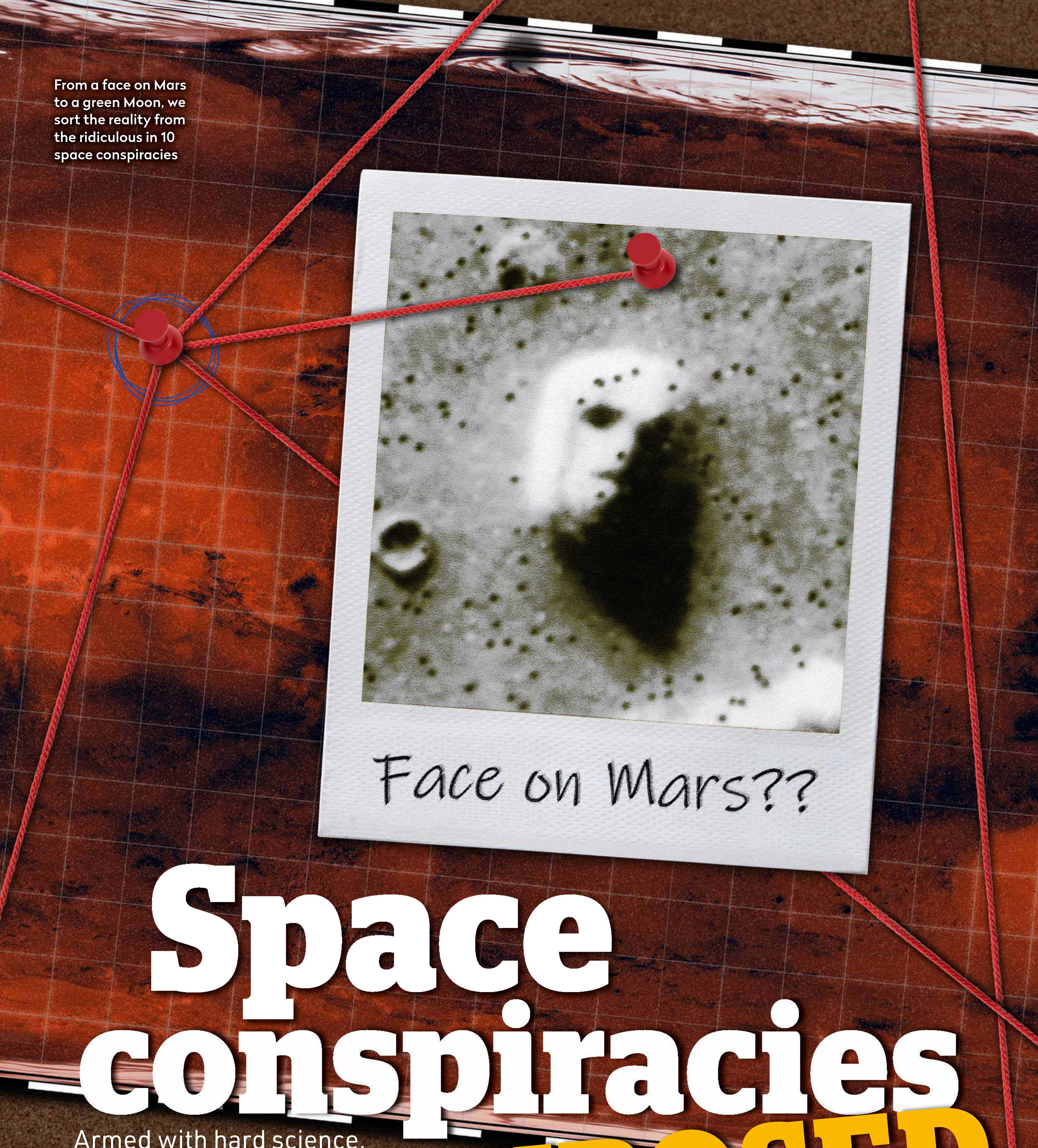
From a face on Mars to a green Moon, we sort the reality from the ridiculous in 10 space conspiracies


Face on Mars??

Space conspiracies EXPOSED

Armed with hard science, **Alastair Gunn** takes apart 10 of the most popular and persistent space conspiracy theories

GETTY X 3 | NASA, JPL

Humans love conspiracy theories. From the JFK assassination, the Illuminati and the 'deep state', to vaccine distrust and 'chemtrails', the modern world is awash with beliefs in collusion and hoaxes.

How and why these baseless claims arise, and what maintains them, are complex questions. But one thing's for sure: contrarian narratives are not going away. Here are 10 widely held falsehoods concerning space and our place within it, which we examine rationally. It's safe to say they don't stand up to scrutiny... ▶

ILLUSTRATION

Disc-credited: even the ancient Greeks knew the flat Earth model crumbles under scrutiny

1. Planet Earth is flat

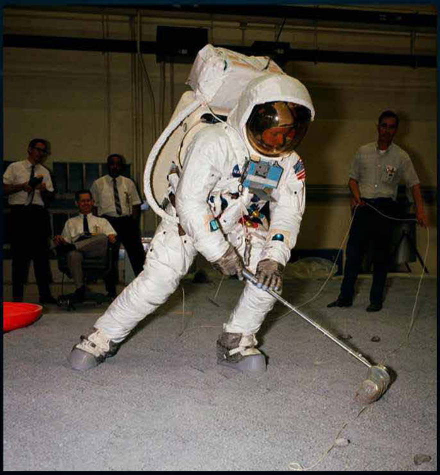
▶ Let's start with perhaps the strangest conspiracy theory of all: that Earth is flat. The basic premise is that ancient cultures were right – Earth is a circular disc that is perfectly stationary while the sky rotates above it. Furthermore, the idea that Earth is a sphere is a villainous lie spread across millennia by an evil, secret establishment.

There are many reasons (or excuses) flat Earthers give for this belief: Earth looks flat; we don't feel Earth moving; NASA has faked images of the spherical Earth; gravity doesn't exist; ships don't sink below the horizon; the tides are caused by Earth moving up and down; explorers who have discovered the edge of the world have been silenced; the Moon generates its own light; artificial satellites don't exist... and so on. All of these can be easily disproved or logically discounted.

Exposed!

Disproving the flat-Earth hypothesis is surprisingly easy – so easy that the Greek philosopher Eratosthenes did it in 240 BC. You can actually perform a similar proof yourself. All you need are two synchronised clocks, two sextants (or other devices for measuring angles in the sky), a car and a friend.

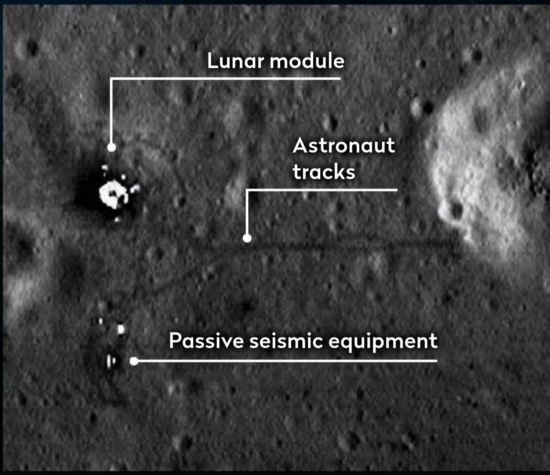
If you and your friend stand exactly 111km (68.9 miles) apart, but are at the same longitude, and both measure (at the same time) the angle of the star Polaris above the horizon, you will find the angle differs by 1°. There are only two possible explanations for this. First, if Earth is flat, Polaris is 6,371km (3,959 miles) above Earth's surface. Second, if Earth is a sphere, it has a radius of 6,371km. We can go further and disprove the first possibility. If Polaris were only 6,371km high, then if you travel 6,371km from the North Pole on a flat Earth, you have made an equilateral triangle and Polaris would be 45° above your horizon. But do the measurement yourself and you will find Polaris is actually 32.6° above the horizon. This is irrefutable proof that Earth is a sphere, of radius 6,371km. Case disproved.



▲ Armstrong in training. Conspiracy theorists love to misread scenes like this

2. The Moon landings were a hoax

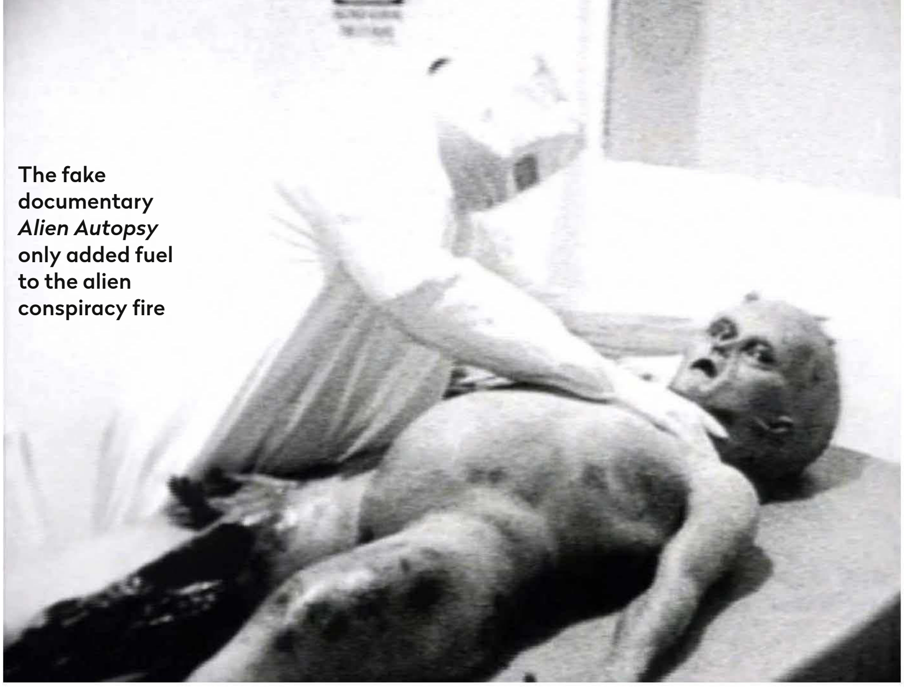
Sadly, NASA is the recipient of much distrust and derision from conspiracy theorists. The agency is accused of faking climate-change data, faking the Apollo 13 disaster and faking Martian surface rovers. But these accusations are dwarfed by the claim that humans never went to the Moon, a belief even more ubiquitous than the flat-Earth theory.



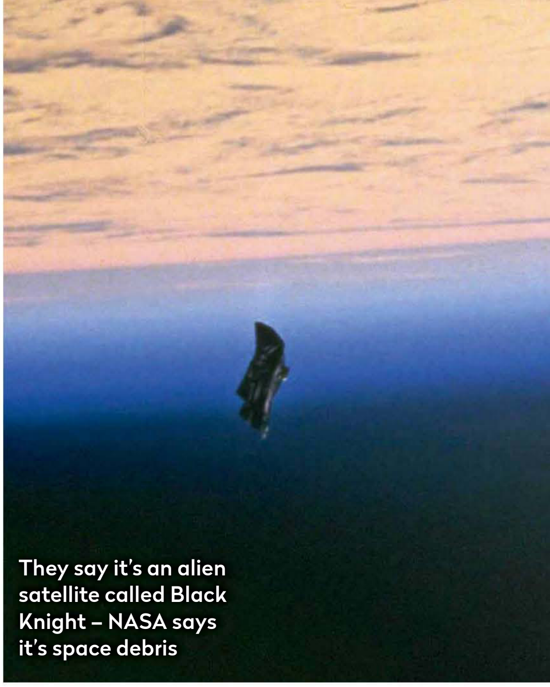
▲ Lunar orbiters show clear signs we've been there – not that deniers are convinced

The idea has a long history, first appearing even before the first Apollo landing, and was undoubtedly given a boost by the 1977 movie *Capricorn One*, in which a manned mission to Mars is faked by NASA. Conspiracy theorists point out that there are no stars in the sky in images taken from the lunar surface. Or that shadows, backgrounds, and even footprints do not appear as expected. They also often refer to the US flag 'waving' when the Moon has no atmosphere, or that astronauts would be

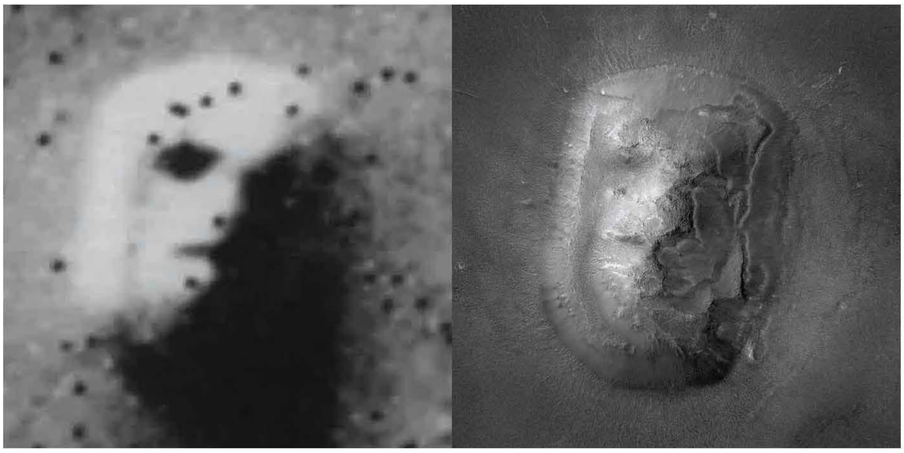
MAHAMUDUL HASAN, GETTY | NASA | NASA, GSFC, ARIZONA STATE UNIVERSITY | ONE MEDIA IP, LTD | NASA X 2, JPL | NASA, JPL, MSSS



The fake documentary *Alien Autopsy* only added fuel to the alien conspiracy fire



They say it's an alien satellite called Black Knight – NASA says it's space debris



▲ The 'face' that launched a thousand theories: Viking 1's 1976 image sparked alien claims, but 2001 Mars orbiter high-res shots proved it's just an ordinary hill lit at a dramatic angle

killed by radiation while passing through Earth's Van Allen belts.

Exposed!

Actually, all of the 'proof' for a faked Moon landing can be easily refuted. For example, there are no stars in the lunar sky because photos were taken in full sunlight and therefore with short exposures. The US flag only 'flutters' when it is moved by an astronaut. The Van Allen belts present no danger to astronauts during the short time they spent within them.

But can we prove that humans went to the Moon? Yes, we can. NASA's Lunar Reconnaissance Orbiter (LRO) has imaged several of the Apollo landing sites from lunar orbit. Lunar module descent stages, the tracks of lunar rovers and even disturbances by the astronauts themselves can clearly be seen.

Plus, laser ranging of the Moon is only possible because Apollo astronauts left behind special mirrors for the task. Unfortunately, even these proofs are often discounted as merely part of the conspiracy and therefore faked. The Apollo project employed about 400,000 people for a decade and cost about £19.1bn ($25.8bn) – more than £180bn or $250bn in today's money. Were all these people part of the conspiracy? What about scientists who have analysed Apollo rock samples? Has NASA managed to dupe all these people too?

Frankly, it would be far more costly and difficult to fake the Moon landings than to actually go to the Moon.

3. The government is hiding aliens from us

Modern science is pretty confident that Earth cannot be the only place in the Universe where life has emerged. The Universe is so huge, so full of stars and planets, and so old, that life – even intelligent civilisations – probably exist elsewhere. Currently, however, we have no evidence of life beyond our tiny planet.

This has not stopped the rise of the 'alien conspiracy', which proposes that governments around the world are already suppressing knowledge of, and contact with, alien beings.

This broad conspiracy theory includes the myth of 'Area 51', the appearance of unidentified anomalous phenomena (UAPs), abductions and experimentation by aliens, and the Roswell incident. Aligned with this is the belief that Earth was visited in prehistory by 'ancient astronauts', or that recently discovered interstellar asteroids or comets are really alien spacecraft.

Unproven!

Despite often-cited 'evidence' for aliens (and their collusion with governments), none of it stands up to thorough scientific scrutiny. Claims are not repeatable, measurable, testable or unambiguous. Most can be discounted, and those that can't do not necessarily imply alien involvement; other unproven but possible explanations can easily be put forward. Case unproven.

4. There's a face on Mars

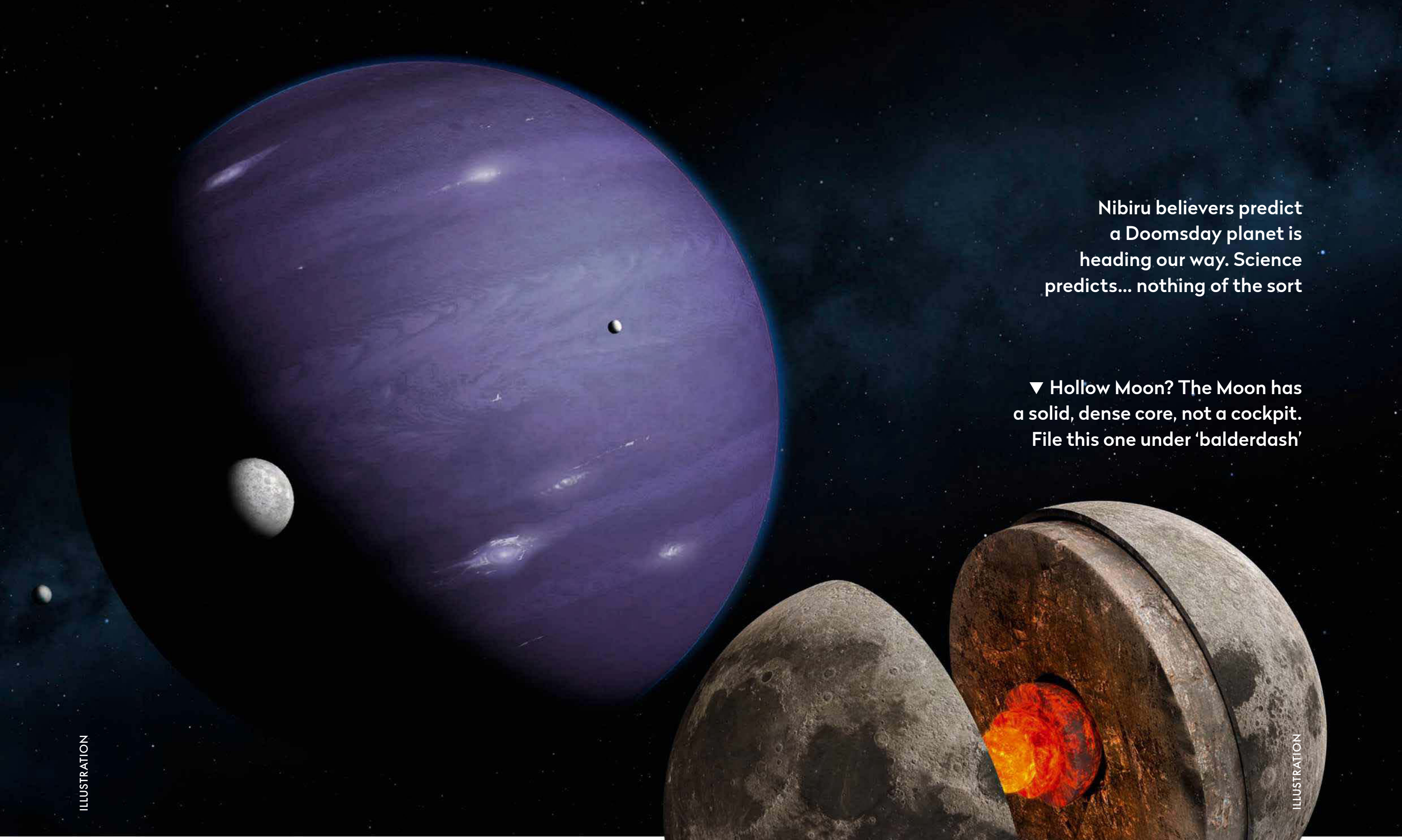
In July 1976, NASA's Viking 1 orbiter took an image of the Martian surface that seemed to show a human face. Later analysis showed that the face was just a trick of the light, the result of specific viewing and illumination angles.

Exposed!

Subsequent high-resolution imagery has revealed the face to be a perfectly natural Martian hill with some depressions that can, under the right conditions, give the appearance of a face. Despite this, some commentators have declared this as evidence of lost Martian civilisations and ruined ancient cities.

5. The Black Knight spacecraft orbits Earth

A popular conspiracy theory holds that an extraterrestrial craft, dubbed 'Black Knight', is in orbit around Earth, and that its existence is being covered up. ▶



Nibiru believers predict a Doomsday planet is heading our way. Science predicts... nothing of the sort

▼ Hollow Moon? The Moon has a solid, dense core, not a cockpit. File this one under 'balderdash'

Exposed!

▶ This seems to be an amalgam of various myths and misunderstandings, and was probably inspired by a NASA photo of space debris taken during a Space Shuttle flight in 1998.

6. Nibiru is coming

The idea that Earth will be destroyed by a collision with a planet called Nibiru was first proposed in 1995 by Nancy Lieder, a Wisconsin woman who claims to have been abducted (and implanted) by aliens. The 'Nibiru cataclysm' has since gained widespread attention.

Exposed!

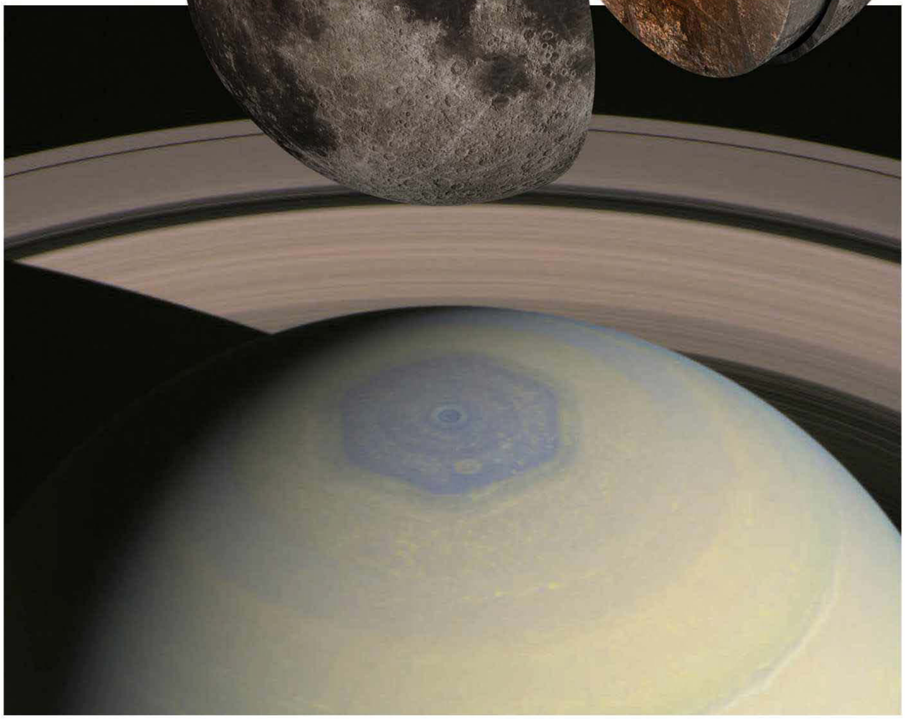
There is no scientific evidence of a planet on a disastrous collision course with Earth. There is a small possibility of a large Planet 9 (or Planet X) floating somewhere in the farthest reaches of the Solar System. This could explain the observed clustering of trans-Neptunian objects (TNOs). Even if eventually found, however, it would not be a threat to Earth.

7. The Moon is hollow

Some claim the Moon is hollow and may be an alien spaceship. This theory gained traction in the 1970s following several pseudoscientific publications.

Exposed!

It's easy to show that the Moon isn't hollow. Data from seismometers placed on the Moon by Apollo astronauts, and countless orbital observations, clearly show the Moon has a solid interior with a thin crust, thick mantle and dense core.



▲ Saturn's north pole hexagon sparked alien theories, but it's just physics: turbulent fluids in a rotating system can naturally form stable polygonal shapes – no aliens required

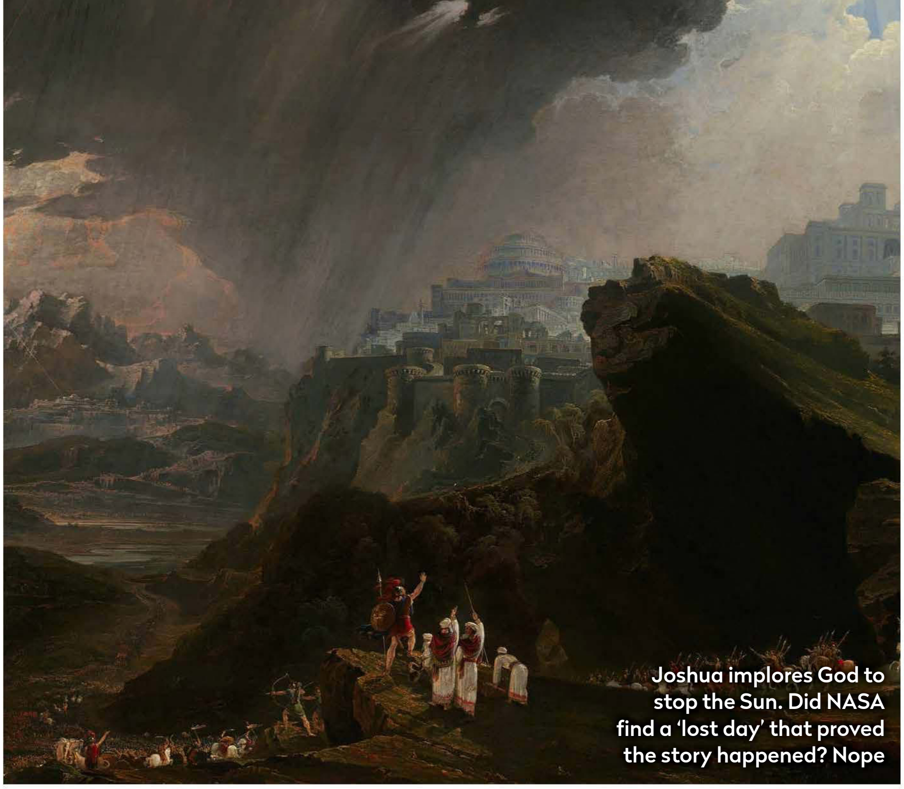
8. Saturn's hexagon is alien-made

During its mission to Saturn in 1981, NASA's Voyager 1 probe discovered an odd hexagonal cloud feature around the planet's north pole. The Cassini mission confirmed it to be about 14,500km (9,009 miles) long. Such an odd shape, which doesn't often occur in nature, has led some to suggest intelligent design.

Exposed!

Numerous studies have shown that such shapes can easily form in turbulent rotating fluids. Nature can always surprise us.

MARK GARLICK, SCIENCE PHOTO LIBRARY, ALAMY | OLEKCII MACH, ALAMY | NASA, JPL-CALTECH, SSI, VAL KLAVANS | PETE LAWRENCE | FLIXPIX, ALAMY



Joshua implores God to stop the Sun. Did NASA find a 'lost day' that proved the story happened? Nope

▲ No, the Moon didn't turn green in 2016. Or in 1847. Or ever – despite what Facebook says

9. NASA found a lost day

In the 1960s, a myth about a 'lost day' gained traction among evangelists. An engineer named Harold Hill claimed that while working for NASA, a missing time period was uncovered when calculating space probe trajectories. He claimed this proved the biblical story of God making the Sun stand still during Joshua's battle with the Amorites.

Exposed!

Hill never worked for NASA, and the story is completely undocumented. Still, many believe that NASA found a missing day and is hiding the truth.

10. The Moon was green

More hoax than conspiracy, the infamous 'green Moon' meme began in 2016 with a single Facebook post claiming that on 29 May the Moon would turn green due to an alignment with Uranus, the first since 1847.

Exposed!

The hoax has resurfaced annually ever since. Despite its increasingly tongue-in-cheek tone, it's still believed far and wide.

Sadly, no amount of reasoned debate can shake these 10 beliefs for true conspiracy followers. Arming ourselves with clear, testable evidence is the best defence – but perhaps the healthiest response is to accept these theories as an often humorous quirk of human nature.

Alastair Gunn is a radio astronomer at Jodrell Bank Observatory in Cheshire

Conspiracies we can't disprove

Even science struggles to counter theories built on what we can't know

Although most conspiracy theories can be falsified, scientifically or logically, some by their very nature can't be disproved. This doesn't make them true, of course; it simply means there's no available counter-evidence.

One example is the zoo hypothesis, often used to resolve the so-called Fermi paradox. Given that the Universe is so vast and old, and that Earth is presumably not the only place where life can develop, why is there no evidence of extraterrestrial intelligence? This is the Fermi paradox, often summed up with the question: "Where are they all?"

The zoo hypothesis proposes that extraterrestrial civilisations have deliberately avoided contact with Earth, for any number of reasons, thus relegating us to an uncontaminated 'laboratory' or 'zoo'. In other words, the entire Universe is conspiring to ignore us!

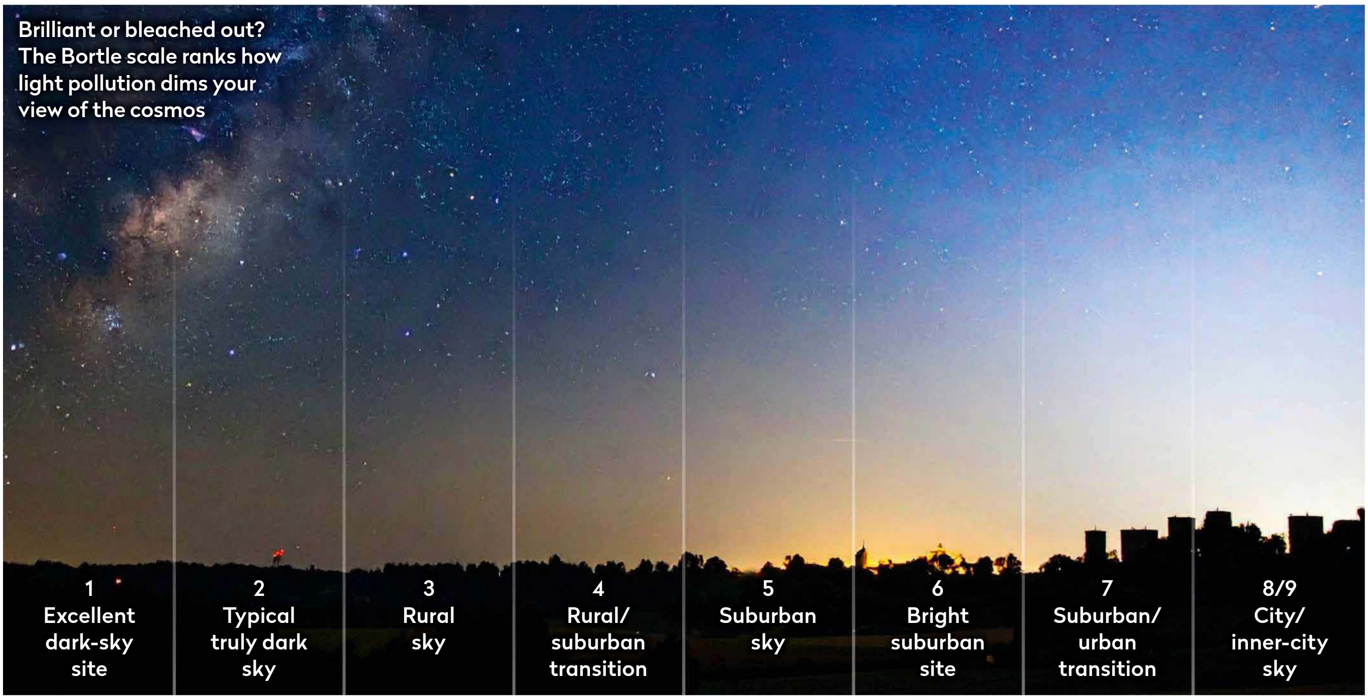
Of course, if the evidence for a theory is an *absence* of evidence, it cannot possibly be disproved. Conveniently, perhaps.

Another 'unfalsifiable' theory proposes that the entire Universe (including us) is merely a Matrix-like simulation. Since we don't know what entity is running the simulation, or how, or what the evidence for it would be, the theory remains impossible to disprove.

Maybe we are in a Matrix-like simulation. It's impossible to prove – or disprove

The fundamentals of astronomy for beginners

EXPLAINER



Brilliant or bleached out? The Bortle scale ranks how light pollution dims your view of the cosmos

How dark is your sky?

Discover the Bortle scale, a simple way to judge night-sky quality wherever you are

Your new telescope arrives and you plan to take it for a spin through the stars. But a smog of light sits low in the sky, washing away your views to distant galaxies – along with your astronomy dreams. Quickly you realise you need a quality dark-sky site. But how dark is dark? And how do we compare one location's sky to another? Enter the astronomer's friend: the Bortle scale.

Amateur astronomer John E Bortle set out to create a sky-brightness scale that would be easily accessible to stargazers and scientists alike. Launched in 2001, it was quickly adopted by anyone curious about the darkness of their skies, and how theirs stacked up against others.

Light pollution, even in small amounts, impacts our view of the cosmos. Sadly, 99 per cent of Americans and Europeans live under light-polluted skies. This means that the majority of us have to travel if we want to experience a truly dark sky that offers unobscured views of distant stars, galaxies and other phenomena that are otherwise lost to light.

The Bortle scale runs from an increasingly rare Class 1: excellent dark-sky site, to the smothered skies of Class 9: inner-city sky. Here's a breakdown of what each level means, so you know what to expect from any rated stargazing site.

Class 1: Excellent dark-sky site

As light pollution extends its grip, these sites are on the road to extinction across much of Europe. Here, the night sky is unimpeded by any artificial light at night. They've got it all: Zodiacal Light, gegenschien, and the Triangulum Galaxy, M33, and the Orion Nebula, M42, are all easily seen by the naked eye. One of the most magical features of these sites? The Milky Way is so bright it can cast a shadow on the ground.

Class 2: Typical truly dark sky

Away from any major settlement we get to Class 2. These sites can sometimes be found closer than you think, if they're shielded by natural features such as hills and mountains, although even here the sky is not truly black. The Orion Nebula is easily visible unaided.

Class 3: Rural sky

For many of us, Bortle Classes 3 and 4 are likely to be the most accessible, with some travel. Light pollution creeps in, visible as domes on the horizon, meaning you'll lose detail in the Milky Way at the horizon but still get lots of detail visible overhead,

NOIRLAB, NSF, AURA (AI MODIFIED) | YUGA KURITA, GETTY | ALEX LINGHORN, GETTY

The Orion Nebula makes a handy barometer – from radiant jewel in Bortle 1 to blurry smudge in Bortle 7

▲ With city lights blazing *and* a full Moon to contend with, all but the very brightest night-sky objects vanish. Stargazing becomes near impossible without specialist filters

especially through binoculars. M42 and the globular clusters M4 and M22 are all visible with the naked eye. You'll need averted vision to catch M33. Any clouds appear dark overhead, but if they hover over the horizon they will be illuminated.

Class 4: Rural/suburban transition Sky
Light domes fill the horizon in almost every direction over settlements, but the sky is still dark overhead. When well above the horizon, the Milky Way is still visible, mainly definable by the Great Rift. It's still possible to see the Orion Nebula, M42, with the naked eye.

Class 5: Suburban sky
Light pollution is visible in most – if not all – directions, erasing the Milky Way completely on the horizon and making it appear noticeably faded even directly overhead. Any clouds are brightly lit by artificial light at night. We start to really lose galaxies, with M33 and M42 barely visible without binoculars or scopes.

Class 6: Bright suburban sky
The entire horizon is aglow with light pollution, completely destroying views of the Milky Way unless you're looking directly overhead – and even then, you'll be using a fair bit of your imagination to make it out. Viewing M33 and M42 is now impossible unless you have binoculars. On the plus side, you won't be fumbling in the dark to find your equipment here!

Class 7: Suburban/urban transition
The night sky is obliterated by light and turned a murky shade of white. Bright light sources illuminate any clouds. Milky Way? No chance. Realistically, you're not seeing much without binoculars or a telescope, beyond our brightest winter constellations such as Orion.

Class 8: City sky
Darkness has well and truly vacated the premises. The sky glows in shades of grey or orange, and even our brightest constellations and planets struggle against such a strongly lit sky. A telescope is your only hope here, and even then, the brightest Messier objects such as M31, the Andromeda Galaxy, are mere shadows of their former selves.

Class 9: Inner-city sky
The sky is permanently ablaze with light. The only real observable objects in the night sky are the Moon, the brighter planets and passing satellites. Not even the brightest winter constellations fully perforate the heavy blanket of light pollution. A very sad sky.

Using this scale, assess your home skies and see how they compare to other sites. Take a star chart or planetarium app and find the faintest star you can see with the naked eye. This is somewhat subjective as it's based on human perception, so expect small variations. Remember to take into account the Moon phase, as even a Bortle 1 site becomes a Bortle 7 under the glare of a full Moon. Always allow at least 20 minutes for your night vision to fully develop, as this will help you pick out the faintest visible targets.

Now, put your new knowledge into practice and get planning your next night under the stars. Whether at home or further afield, now you'll know just how in the dark you are!

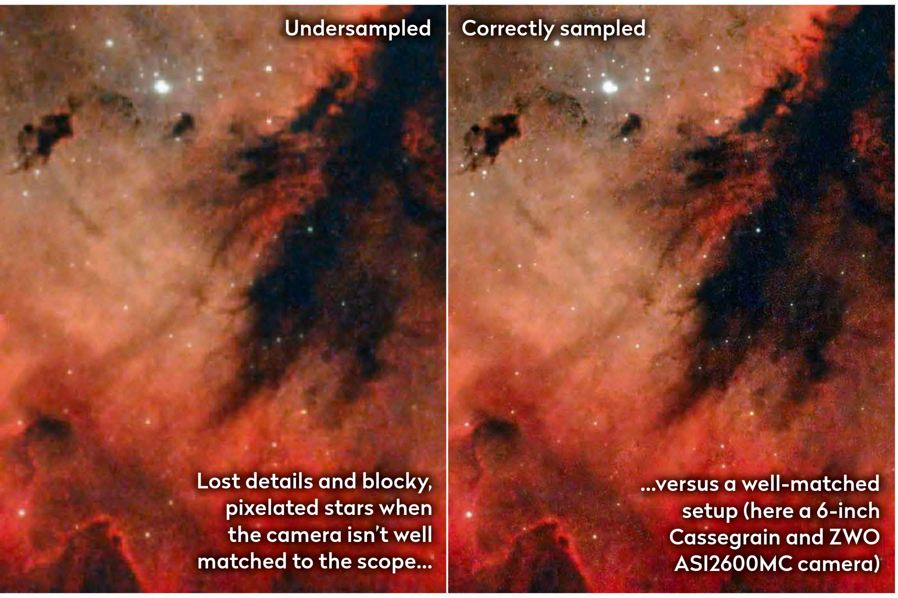
Dani Robertson is a Dark Sky Officer for Eryri National Park (Snowdonia) and recipient of the Dark Sky Defender Award in 2022

Practical astronomy know-how for every level of expertise

SKILLS FOR STARGAZERS

Match your setup to your seeing

Optimise your gear to get sharper astrophotos whatever your sky conditions



Lost details and blocky, pixelated stars when the camera isn't well matched to the scope… …versus a well-matched setup (here a 6-inch Cassegrain and ZWO ASI2600MC camera)

The quality of your astro images isn't just down to your processing skills. Key is the relationship between your telescope's optics, your camera's imaging chip and your local atmospheric 'seeing' conditions. Locations with steep temperature gradients and turbulent air – such as urban areas – usually mean poor seeing conditions that distort starlight and blur images.

While you can't do much to reduce poor seeing – short of opting to image higher-altitude targets – you *can* optimise your setup for your local environment by understanding your image scale and image sampling rate. Here's how to match your gear to the sky for sharper, more detailed results.

Find your ideal scale

Seeing conditions can be summarised as the 'full width at half maximum' (FWHM) of stars, and are measured in arcseconds. This indicates how much the starlight is being spread out due to turbulence before it hits your camera sensor. A lower FWHM value indicates good seeing conditions and sharp stars, while a higher FWHM value implies poor seeing conditions. Typical FWHM values are: 2–4 arcseconds in average seeing conditions; 1–2 arcseconds in better-than-average conditions; and closer to 5 arcseconds for poor seeing.

Image scale relates to your camera's ability to capture detail from your scope, and depends on its pixel size: it tells you how much sky, in arcseconds, each pixel covers. This value is key to determining your system's image sampling rate, which is how finely it samples the incoming light.

You can work this out by using the Nyquist sampling theorem, which outputs your image scale in arcseconds per pixel. It's calculated by dividing your camera's pixel size (in microns) by your telescope's focal length (in millimetres), then multiplying by 206.265. If you live in an area of okay or average seeing, you want the resulting image scale to be between 0.67 and 2 arcseconds per pixel.

If you combine a long-focal-length telescope with a camera that has smaller pixels, you might 'oversample' your images, which would be indicated by an image scale lower than 0.67 arcseconds per pixel. Oversampling can lead to bloated star shapes because the pixels are too small and the light is spread across too many of them. Pairing these scopes with cameras with larger pixels helps, as will imaging from a location with good-to-excellent seeing.

On the other hand, shorter-focal-length telescopes (or adding a focal reducer to a long-focal-length telescope) increase the resolution per pixel. However, if it exceeds 2 arcseconds per pixel, the image could be undersampled, which can reduce resolution if the pixels are too large to capture fine detail. This results in blocky or pixelated stars and lost details.

Matching your system to your local seeing conditions will give you the best chance of capturing stunning images. But don't worry: if your setup isn't quite hitting the sweet spot, with a bit of knowledge and experimentation, you can get great images even under average skies.

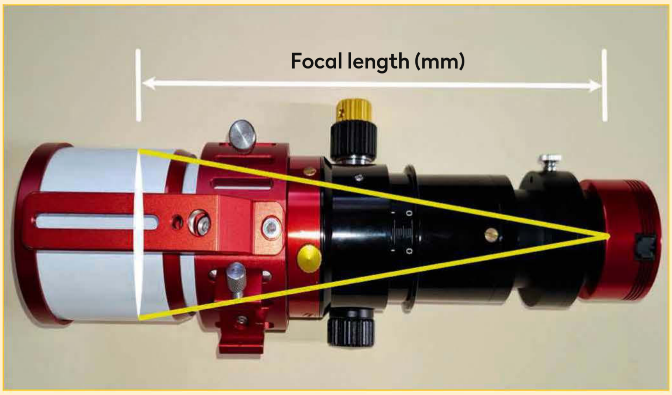
Dave Eagle is an astronomer, astrophotographer, planetarium operator and writer

What you'll need

- A telescope with a known focal length (in millimetres)
- A CMOS or CCD camera with a known pixel size (in microns)
- Software to calculate image scale, simulate sampling and assist with capture and processing
- A way to measure or look up local seeing conditions
- A focal reducer or Barlow lens to adjust focal length if needed
- Auto-guiding gear to keep tracking accurate during long exposures

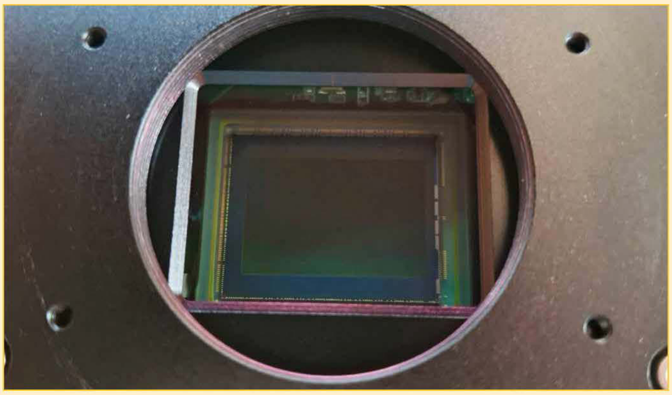
ALL PICTURES: DAVE EAGLE

Step by step



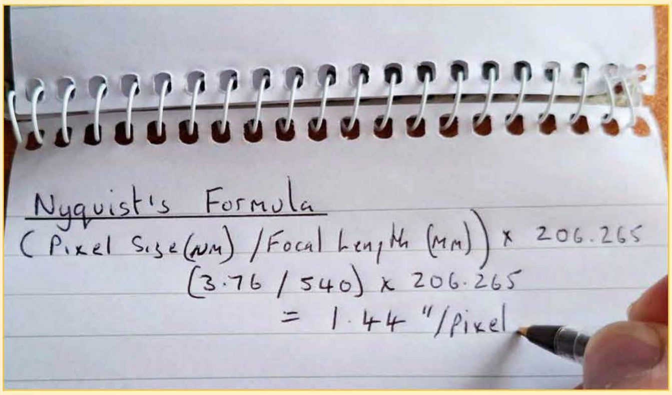
Step 1

Look up your telescope's focal length or calculate it by multiplying its focal ratio (f/ number) by its aperture (in mm). Accurately determining the focal length is essential for precise pixel-scale calculation and matching a camera to your scope.



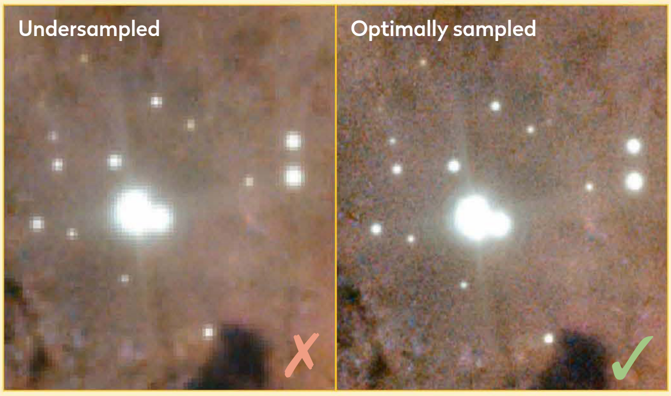
Step 2

Check your camera's pixel size in microns (µm), usually listed in the manufacturer's technical specs. Different cameras, even from the same manufacturer, can have different pixel sizes, which will affect the image scale and sampling abilities.


Nyquist's Formula
(Pixel Size (µm) / Focal Length (mm)) x 206.265
(3.76 / 540) x 206.265
= 1.44 "/Pixel

Step 3

Calculate the pixel scale using Nyquist's formula: (pixel size in µm ÷ focal length in mm) x 206.265. This gives the angular size of the sky that each pixel covers in arcseconds and determines how well your sensor samples the image from the telescope.



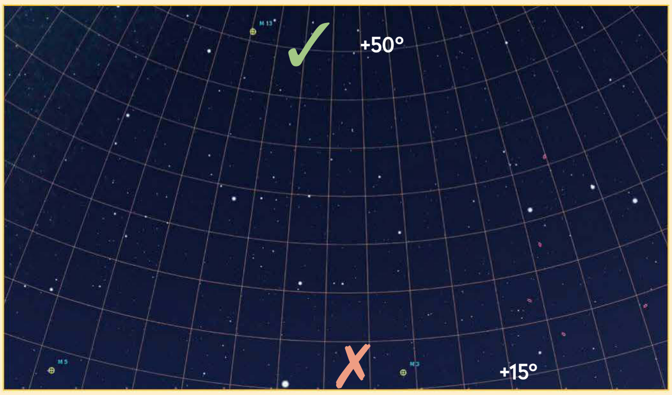
Step 4

Now compare the pixel scale to your local seeing conditions. Ideally, it will fall within 0.67–2 arcseconds per pixel. This balances the effects of average atmospheric turbulence and camera resolution to avoid aliasing and undersampling.

0.8X Photo Reducer

Step 5

Adjust your setup to match the ideal pixel scale and optimise sampling. This may involve adding focal reducers or Barlow lenses, switching to a camera with different-sized pixels, or binning pixels in your software to modify the camera resolution.



Step 6

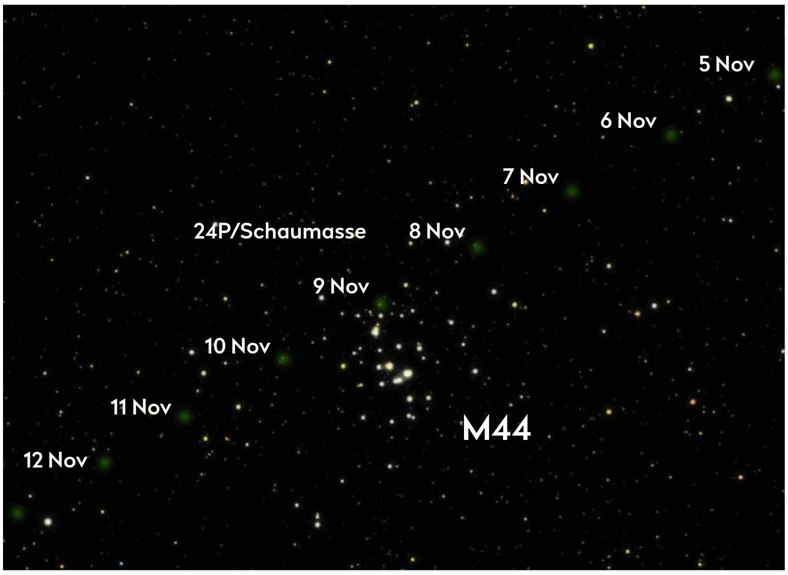
Factor in local atmospheric conditions and optical quality when fine-tuning your setup. Poor seeing or aberrations call for coarser sampling (larger pixel scales). Higher-altitude objects in stable air offer better seeing, finer sampling and sharper results.

Take the perfect astrophoto with our step-by-step guide

ASTROPHOTOGRAPHY CAPTURE

Comet 24P dives into the Beehive

A faint comet sneaks across M44 under moonlight this month. Can you catch it?



▲ Comet 24P/ Schaumasse will buzz the Beehive Cluster this month – an excellent chance to locate this faint comet under difficult circumstances

Comet 24P/Schaumasse is a faint comet, but definitely within reach of amateur imagers. It's really well placed on 7–11 November, passing in front of the Beehive Cluster, M44 (read more on page 47). But there are two challenges. First, 24P is expected to be dim during November, shining at mag. +14.3 or so. That's manageable for deep-sky setups, but then there's the second problem: the Moon. During the comet's passage, the Moon lies west of M44 and will be just past a perigee full phase, meaning it'll be bigger and brighter than average. Ouch!

Don't be put off though. Any attempt to image the comet offers good practice for later weeks, when 24P becomes brighter and the Moon moves out of the way. The fact that M44 is easy to see will at least guarantee that you have the right patch of sky. The hard bit will be getting any image of the comet itself. Don't expect to grab a 'pretty' shot – your goal will be to simply capture something.

Smart scopes should locate M44 easily, even with the Moon's glare. Simply search for the cluster, instruct the telescope to locate it and start imaging.

ALL PICTURES: PETE LAWRENCE

Pete Lawrence is an expert astro-imager and a presenter on *The Sky at Night*

But then comes the fun part, because however simple that process is, the bright Moon will likely wash out the comet. Any post-capture editing skills you've learned will come to the fore to extract any faint signature of 24P within the cluster.

Next stop: Leo's Sickle

It's good to challenge yourself sometimes and work hard to get a result, but even if your efforts to capture the Beehive crossing are fruitless, it's still a useful warmup for later in November when the comet slips into Leo. It will again be in a familiar area of sky – this time, the Sickle asterism representing Leo's head.

The passage across the Sickle begins around 26 November. In early December, comet 24P is expected to have brightened to around mag. +11.6, making it a much easier prospect to image and see visually. On the night of 1/2 December, it will be very near the mag. +2.0 double star Algieba (Gamma (γ) Leonis), another easy navigational guide.

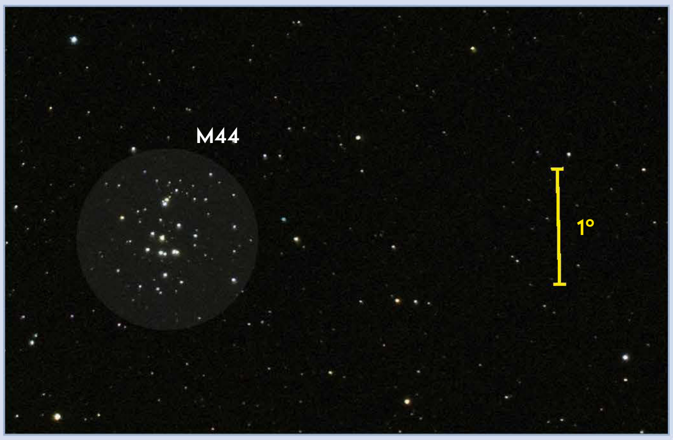
Following this faint comet will give you a rewarding project over the coming months. 24P reaches perihelion on 8 January 2026, when it will be in a region of sky south of Arcturus. It's then expected to have brightened to around mag. +9.9, making it an excellent and exciting imaging target. Before this, it'll be passing though some great deep-sky real estate in Coma Berenices, with some wonderful faint fuzzy galaxies to keep it company.

If you manage to stay the course and follow 24P through to this period, you'll look back on your attempt to capture the tricky Beehive crossing this month as the start of a journey. Tracking an object like this give you a unique attachment to it, improving your skills along the way as well.

Equipment: Smartscope, DSLR or equivalent with a 200mm or shorter focal length lens or telescope

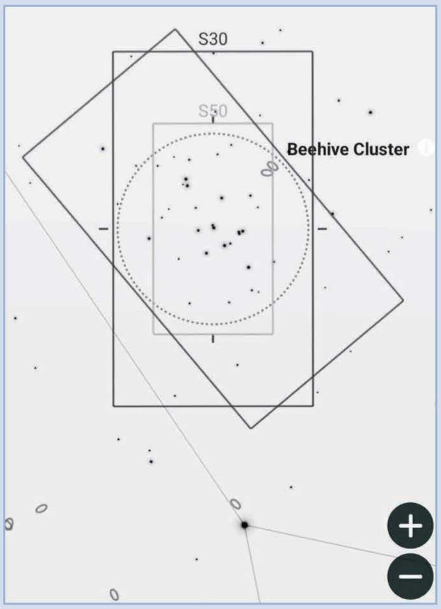
✉ **Send your images to:**
gallery@skyatnightmagazine.com

Step by step



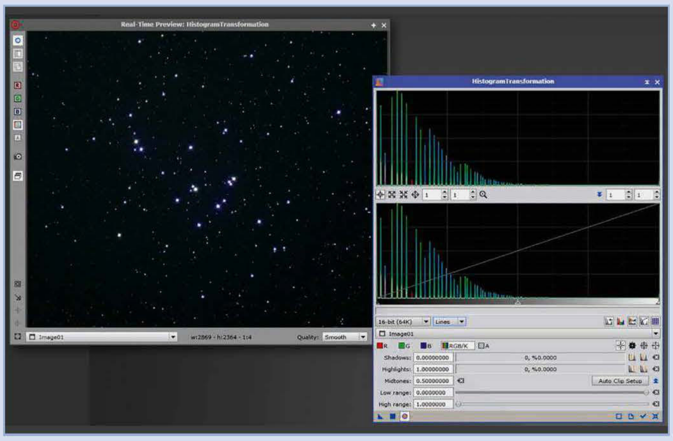
STEP 1

M44 is a large open cluster shining at a magnitude of +3.5 and with an apparent diameter approaching 1.2°. If you hope to capture the comet's motion across the entire cluster, the best way will be to image the whole of M44 in one go – but be aware that the comet may appear small and faint.



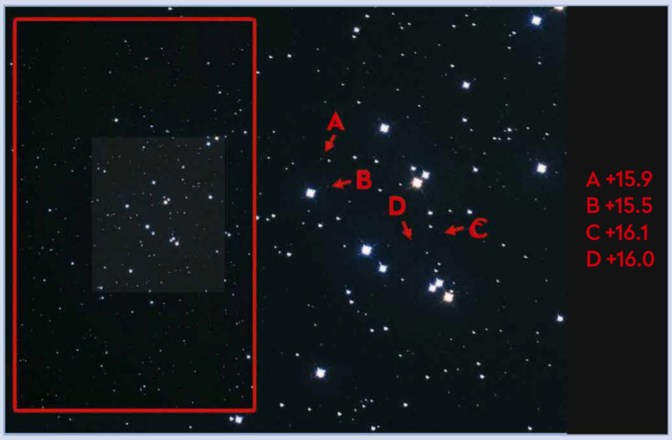
STEP 4

This comet's passage across M44 is a great way to put your smart scope to good use if you have one, as it will be able to locate the cluster even with the Moon nearby. It may struggle after 10 November when the Moon is very near M44, especially if the sky is hazy. Find out your smart scope's field of view and compare it with the size of the cluster.



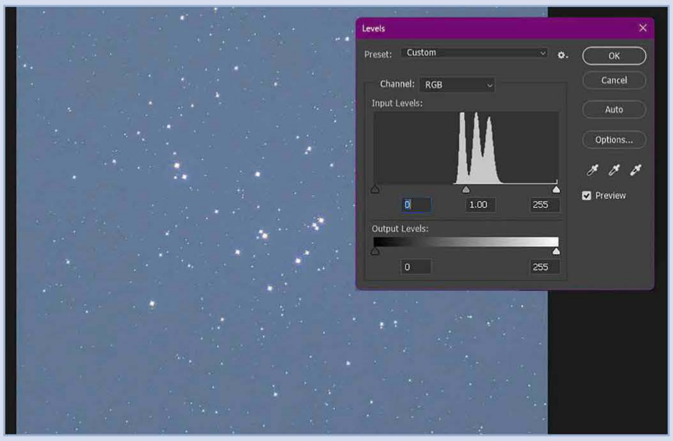
STEP 3

If skies are clear at the start of November, use your best deep-sky imaging skills to grab a reference image of the Beehive Cluster. If you're using a smart scope, it's a good opportunity to explore advanced image-processing techniques. Default results may be fine, but extra processing should give better results.



STEP 4

Image the cluster for as many nights as possible between 7/8 and 10/11 November. You'll need to go deep enough to exceed the comet's estimated magnitude of +14.3 – and since that's an integrated magnitude, it may appear even fainter. Achieve mag. +16.0 and you should stand a solid chance of capturing 24P.



Preset: Custom

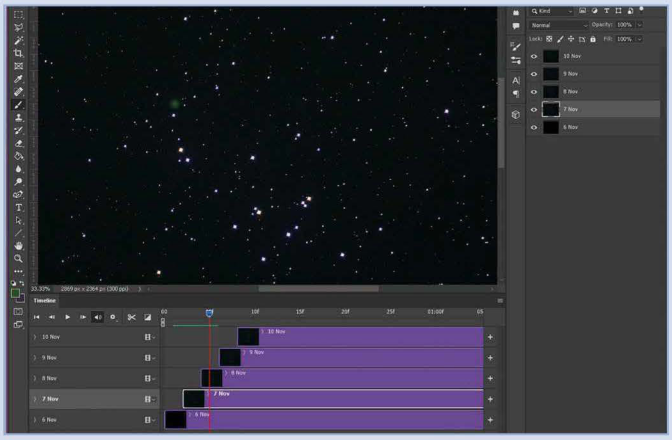
Channel: RGB

Input Levels: 0 1.00 255

Output Levels: 0 255

STEP 5

The bright Moon will lighten the background more than usual. With a conventional setup, exposures that might normally seem far too bright should be fine, as long as the sky isn't totally saturated. Process as usual, then adjust the histogram to darken the sky and bring out the stars – and hopefully 24P.



STEP 6

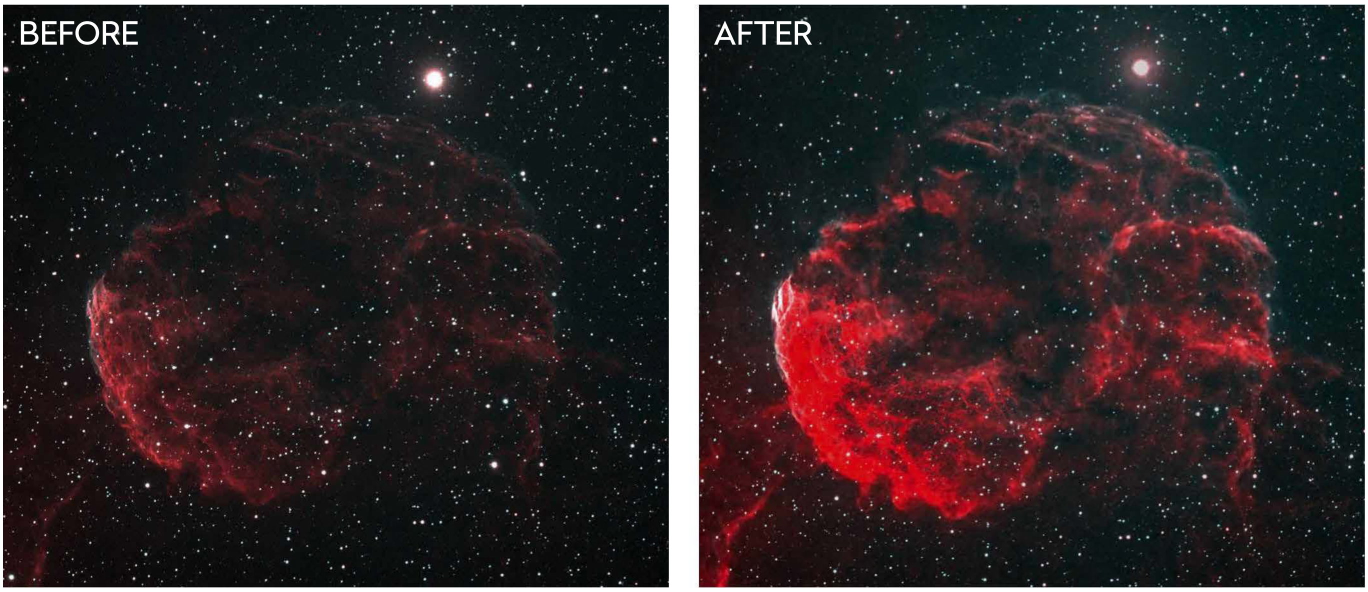
Think you've caught the comet? Combining your images from several nights into a flick-book animation should confirm it. To do this, use a layer-based editor with animation tools, such as Photoshop or GIMP. Load one image per layer, in date order, align the cluster stars across layers, then create your animation.

Expert processing tips to enhance your astrophotos

ASTROPHOTOGRAPHY PROCESSING

An introduction to StarTools

Reveal detail and reduce noise with this easy-to-use toolkit



▲ **We used two key StarTools tools – High Dynamic Range (HDR) and noise reduction (NR) – to tackle noise and tease out the delicate, hidden details in the Jellyfish Nebula, taking our stacked image from average (left) to awesome (right) in just a few clicks**

There's a vast array of astronomy image-processing software on the market, often with high initial or monthly costs coupled with a steep learning curve. StarTools offers a full suite of easy-to-use functions that take a basic stacked image and transform it, for a reasonably modest one-off licence fee. A free trial period is available, so you can decide whether it works for you (though you can only save your final image once you've purchased the licence).

All of the functions in StarTools are operated by sliders, with a live view shown in the main window, making it very simple to get to grips with if you're new to image processing. For this walkthrough, we'll use two key tools: High Dynamic Range (HDR) and noise reduction (NR) – powerful features that can dramatically improve your final results. We used a bi-colour image of the Jellyfish Nebula, IC 443, that had been freshly stacked in DeepSkyStacker.

Start the StarTools application and click 'Open' to select the stacked image you want to process. StarTools accepts uncompressed TIFs, PNGs and FITS, so make sure your stacked start image is saved in the correct format.

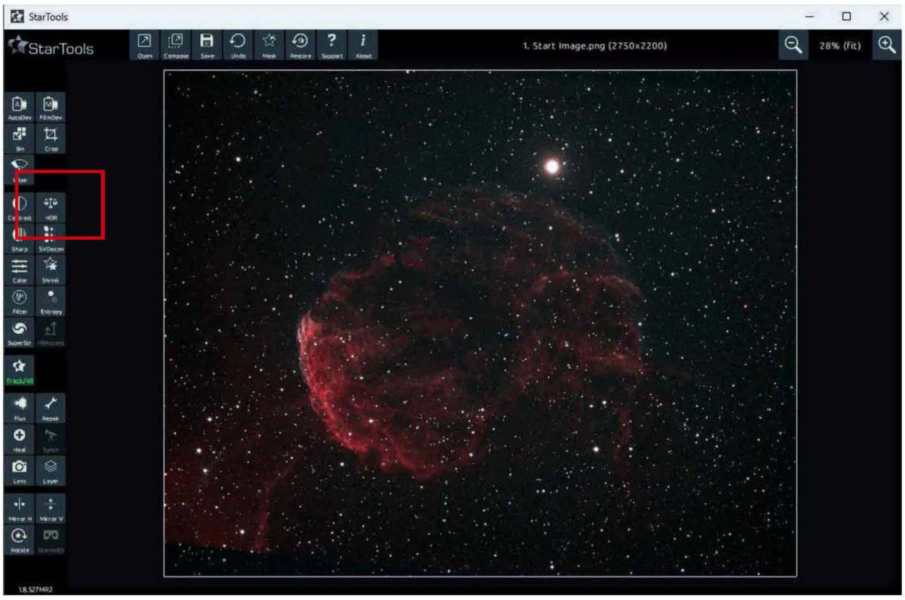
HDR helps tease out fine details from over- or underexposed areas, such as the centres of galaxies or brighter regions of nebulae. From the left-hand panel, select HDR and a new screen opens (see Screenshot 1). Because HDR applies complex enhancements, it can take a little time to show the changes, so first click and drag your mouse to define a 'region of interest' within your image. With this selected, the changes you make are only applied to this area in the preview, which significantly reduces the processing time.

Dial up the detail

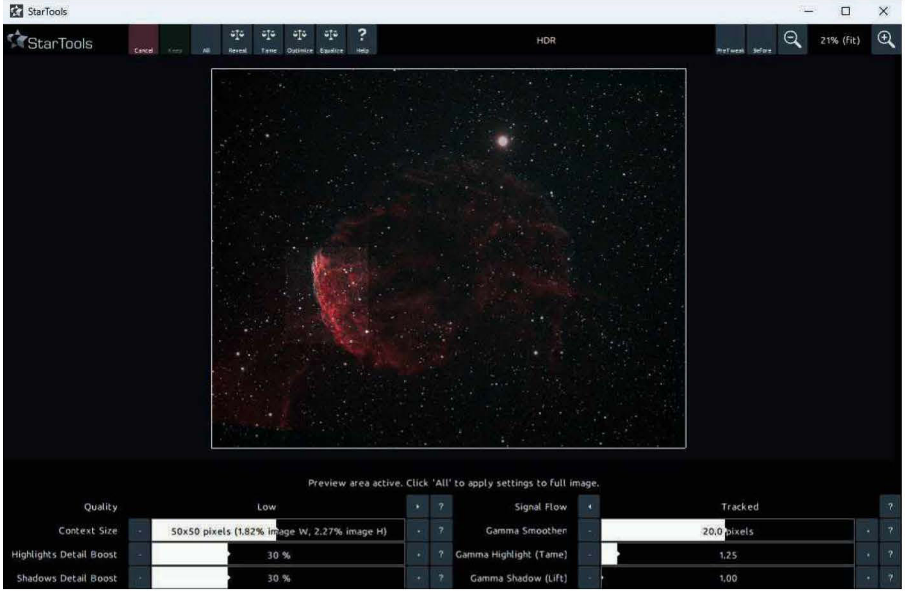
Across the top of the screen are a set of presets that are a great starting point. We selected the 'Reveal' preset as this has been specially built to help pull out fine details. Once a preset is selected, you can use the sliders at the bottom of the screen to make additional adjustments (see Screenshot 2). For our image, we reduced the 'Context Size' slider to ensure the finest details were captured, and increased the 'Highlight Detail Boost' and 'Shadow Detail Boost' sliders. Finally, a tiny increase to 'Gamma Shadow' helped to make details pop.

Once you're happy with your adjustment, click 'All' to apply the

ALL PICTURES: CHRIS GRIMMER


StarTools
Open
Compose
Save
Undo
Mask
Restore
Support
About
1. Start Image.png (2750x2200)
28% (Fit)
AutoDev
FilmDev
Bin
Crop
Wipe
Contrast
HDR
Sharp
SVDecon
Color
Shrink
Filter
Entropy
SuperStr
Track/NR
Flux
Repair
Heal
Synth
Lens
Layer
Mirror H
Mirror V
Rotate
Stereo3D

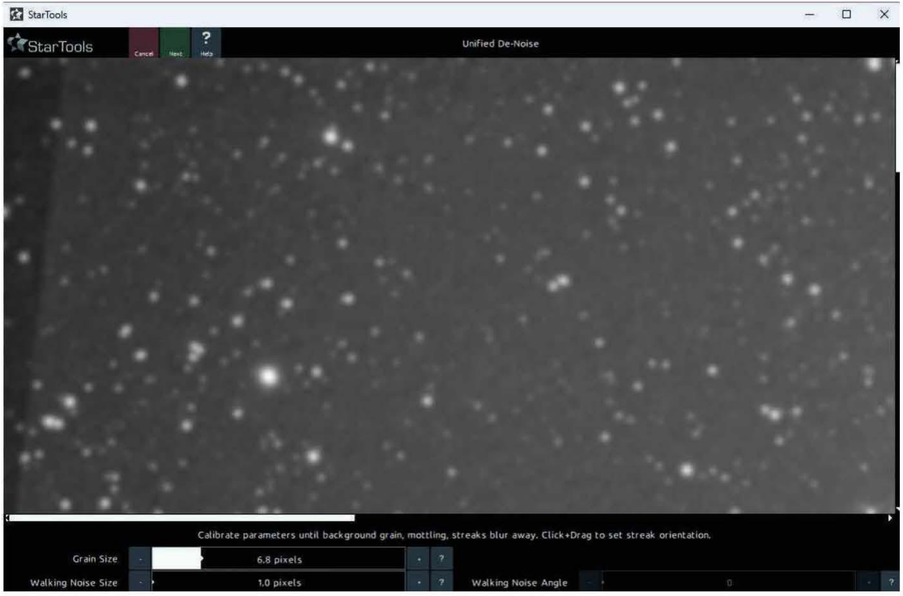
▲ **Screenshot 1: open your stacked image and select HDR from the left-hand panel. Click and drag to set a preview area that will show the effects of any changes that you make**


StarTools
Cancel
Keep
All
Reveal
Tame
Optimize
Equalize
Help
HDR
PreTweak
Before
21% (Fit)

Preview area active. Click 'All' to apply settings to full image.

Quality: Low
Context Size: 50x50 pixels (1.82% image W, 2.27% image H)
Highlights Detail Boost: 30 %
Shadows Detail Boost: 30 %
Signal Flow: Tracked
Gamma Smoother: 20.0 pixels
Gamma Highlight (Tame): 1.25
Gamma Shadow (Lift): 1.00

▲ **Screenshot 2: choose a preset at the top of the screen, then use the sliders to refine your results, boost highlights and shadows, and extract fine details. Click 'All' to apply**


StarTools
Cancel
Next
Help
Unified De-Noise

Calibrate parameters until background grain, mottling, streaks blur away. Click+Drag to set streak orientation.

Grain Size: 6.8 pixels
Walking Noise Size: 1.0 pixels
Walking Noise Angle: 0

▲ **Screenshot 3: use the AI-powered Track/NR tool to remove streaks, trails and other artefacts. Its default setting gives great results, or you can refine things with the sliders**

3 QUICK TIPS

1. Remember that you can apply each StarTools action more than once to increase its strength and effect.

2. Ensure that Tracking is set to 'on' to process your image luminance and colour separately.

3. Use the Mask function to block out your stars and prevent these from bloating while you process your data.

changes (this may take a few minutes) and then select 'Keep' to save the changes and return to the main screen.

We next selected 'Track/NR', StarTools' AI-powered denoising tool. StarTools monitors and tracks all the changes applied in each stage of your processing, assessing the noise that is introduced and keeping this data ready for the step. Once you confirm whether you want to apply noise reduction, an auto-stretch is applied to the preview area to help you identify the noise. You can then move the 'Grain Size' slider to the right until the noise has been smoothed out (see Screenshot 3). This is where you can also remove walking noise, a type of directional noise that appears as streaks or trails across the image. To do this, click and drag in the direction the noise is moving, then move the 'Walking Noise Size' slider to the right until these artefacts disappear.

Clicking 'Next' in the top-left corner then applies the noise reduction to your whole image. We found that the default noise reduction was perfect – but, again, you can manually adjust the strength applied with the sliders. If the results look good, hit the 'Keep' button.

There is of course a lot more that StarTools can do, but just these two tools can make a real difference to your processed image. As you can see from our 'After' photo, we extracted significantly better details from our Jellyfish Nebula, particularly on the left-hand side where delicate filament-like structures needed careful handling.

Chris Grimmer is an experienced astrophotographer and photographer specialising in infrared images

Your best photos submitted to the magazine this month

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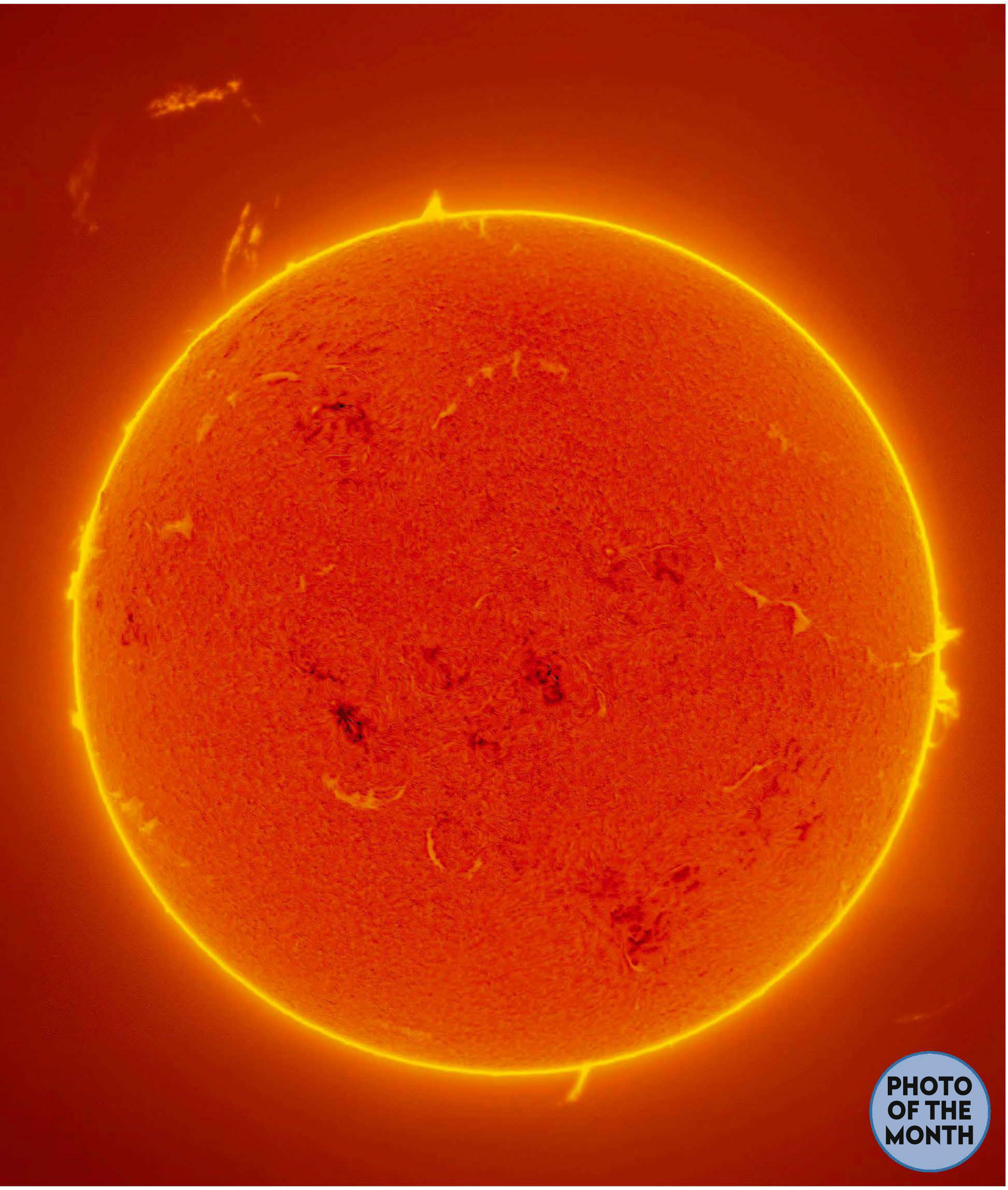


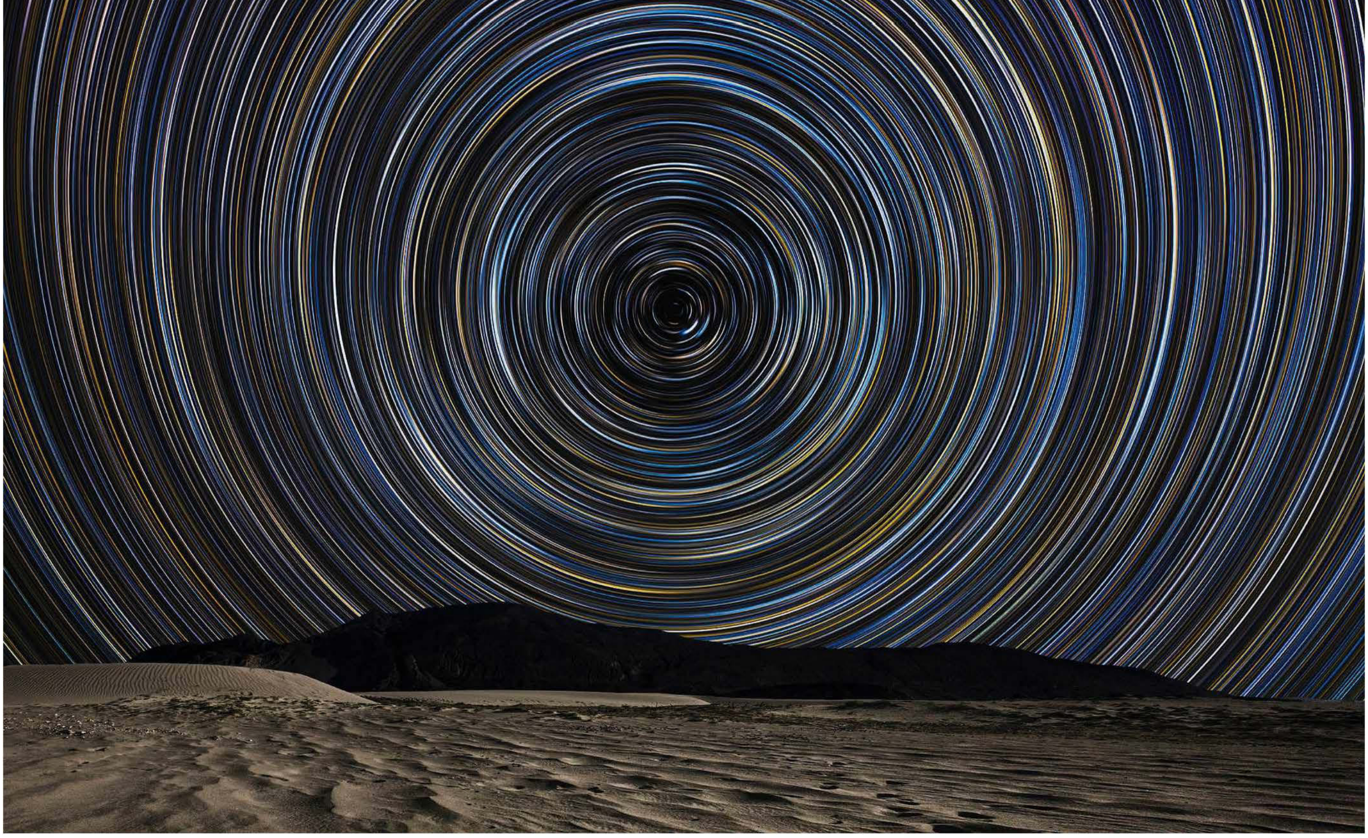
PHOTO OF THE MONTH

◁ Solar prominence

Anton Matthews, Bristol, UK, 3 July 2025

Anton says: "Towards the end of an early morning session, I took one more look and spotted this prominence. I'd never seen, let alone imaged, one this far from the disc."

Equipment: ZWO ASI174MM camera, Coronado SolarMax II 60 solar telescope, Sky-Watcher AZ-GTiX mount
Exposure: 10-panel mosaic, 1,000 frames each, 114fps
Software: ImPPG, Microsoft ICE, GIMP
Anton's top tips: "Solar photography can be extremely enjoyable and extremely frustrating! There's always something new to see, so be prepared. I have my solar telescope permanently set up. Make the most of any chances the weather offers and don't be afraid to experiment."



△ Star trails

AJ Singh, Hunder Sand Dunes, Ladakh, India, 21 June 2025

AJ says: "Imaging that night felt like painting on a canvas. I'd never seen sand dunes before. The skies were dark and the Moon rose early, so I decided to capture some star trails."

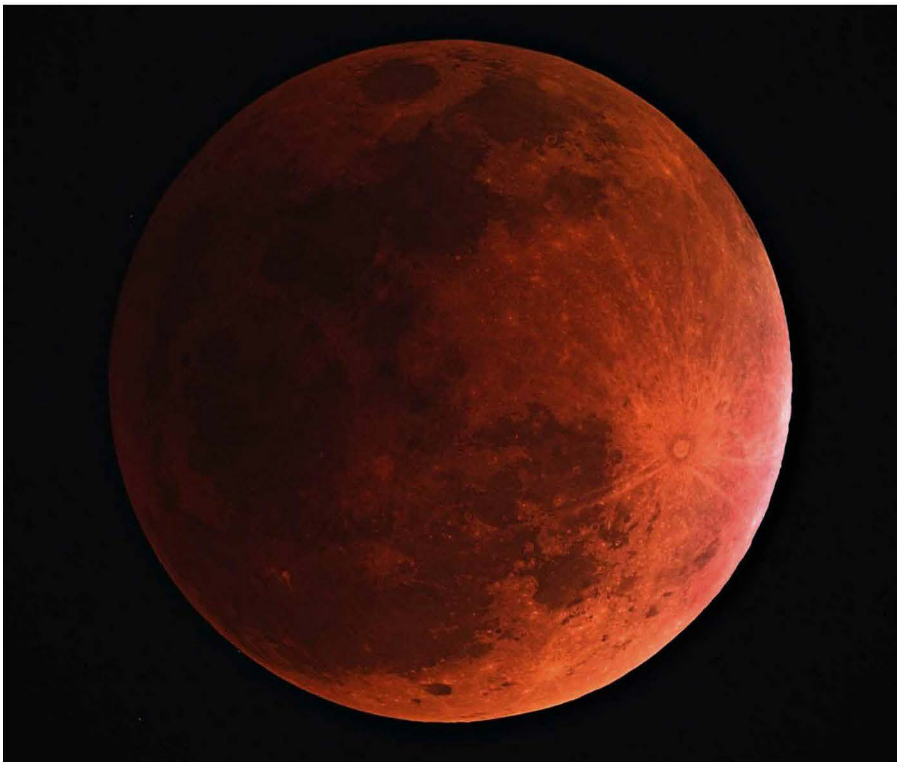
Equipment: Canon EOS R camera, Canon 50mm lens, Sirui tripod **Exposure:** 300x 30"
Software: StarStaX, Photoshop

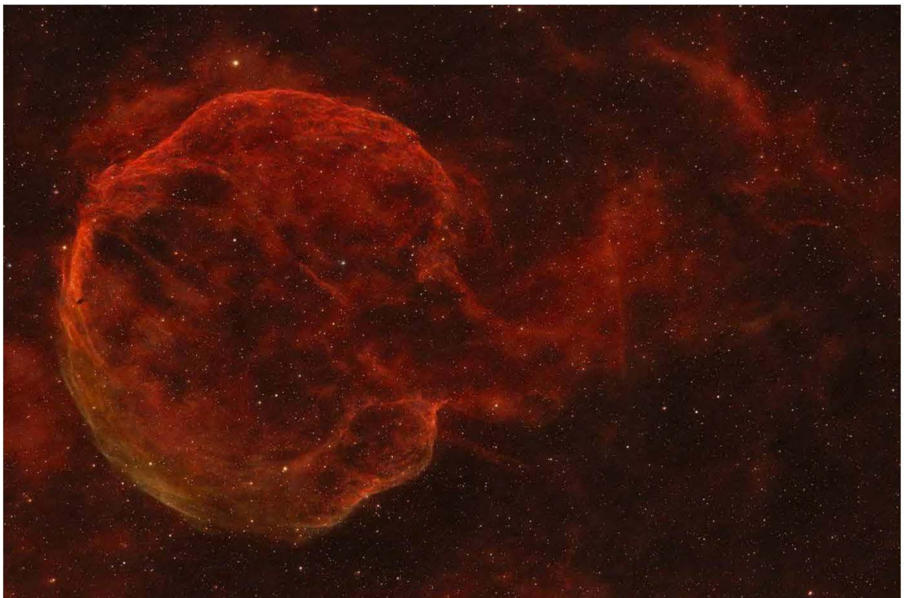
Total lunar eclipse ▷

Prabhu, Mleiha National Park, UAE, 7 September 2025

Prabhu says: "At peak eclipse, the Moon appears deep red as it's fully covered by Earth's shadow. Reduced brightness allows background stars to become visible."

Equipment: Canon EOS RP camera, Celestron Edge HD 11-inch Schmidt–Cassegrain, Celestron CGX-L mount
Exposure: ISO 3200, 6"
Software: PixInsight, Photoshop



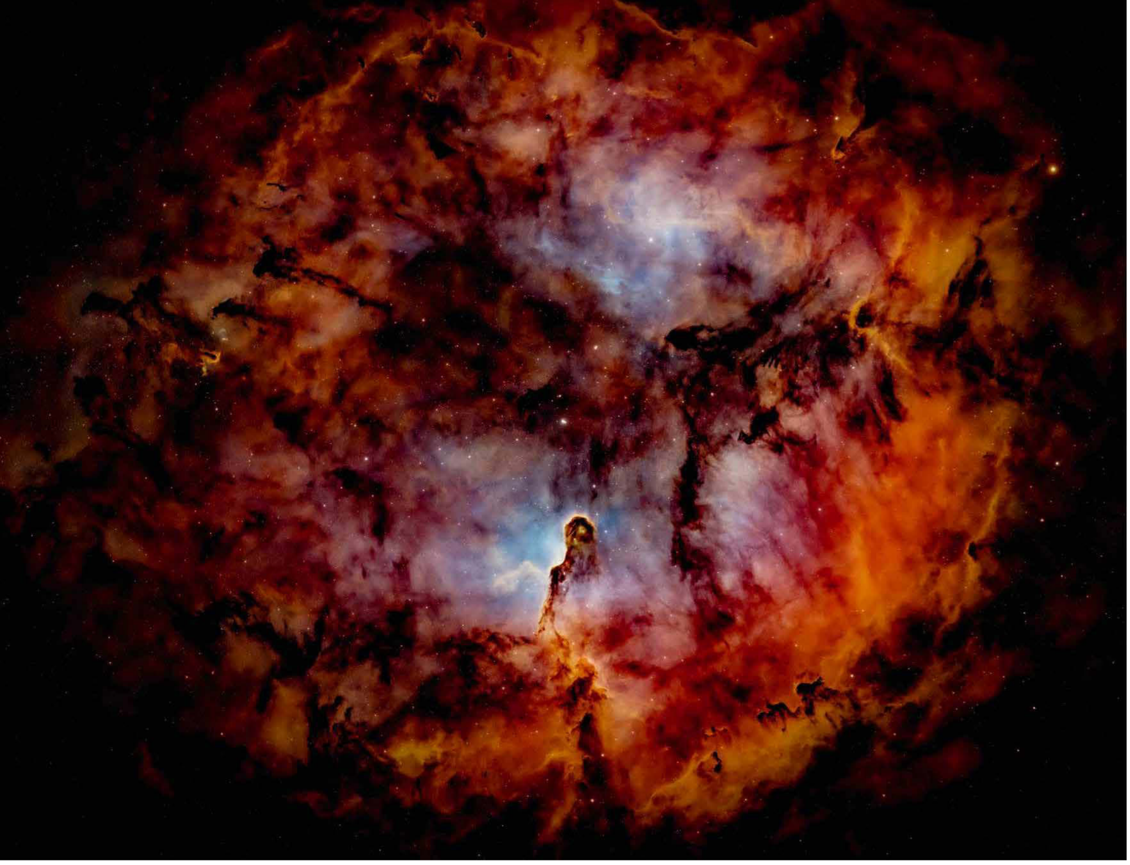


◁ The Garlic Nebula, Abell 85

David Hugill, Cirencester, Gloucestershire, UK, 4 July–14 August 2025

David says: "This target was a challenge due to its faintness. It was difficult to frame and capturing it required over 29 hours of data, but I'm pleased with the result."

Equipment: ZWO ASI585MC Pro camera, StellaMira 90mm ED refractor, ZWO AM5 mount
Exposure: 350x 300"
Software: PixInsight

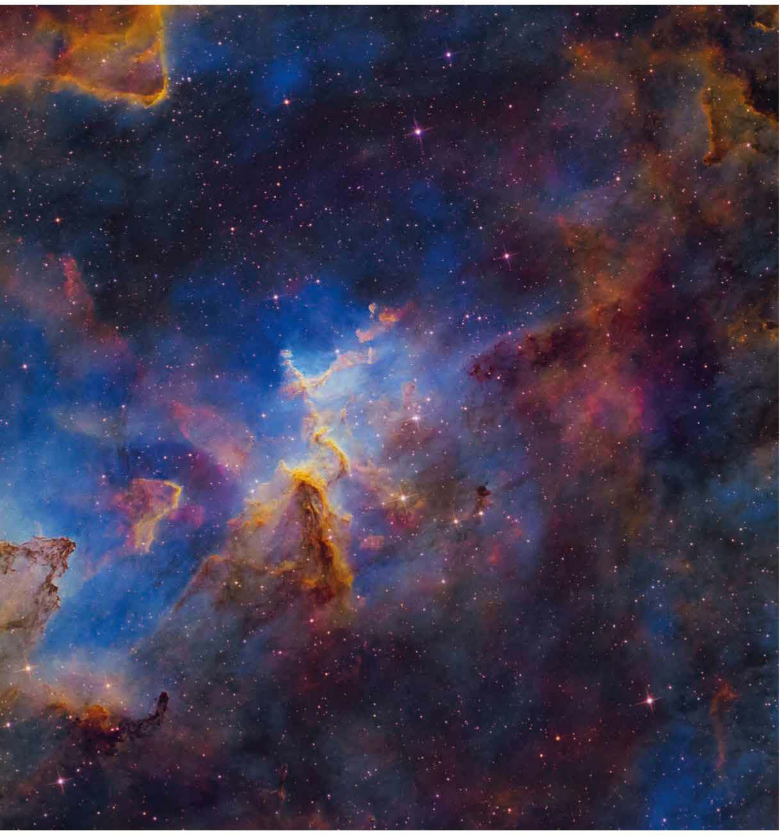


◁ The Elephant's Trunk Nebula

Bill Lowry, Chiddingstone Hoath, Kent, UK, April and May 2025

Bill says: "I chose this target because there's so much going on. It's huge and I really wanted to do it justice, so lots of time was thrown at it!"

Equipment: ZWO ASI2600MM Pro camera, William Optics GT-81 IV refractor, Sky-Watcher EQ6-R Pro mount **Exposure:** LRGB 50x 30", Ha 6x 1,200", 28x 600", OIII 23x 1,200", 10x 600", SII 42x 1200", 10x 600", total 36h 40' **Software:** PixInsight



◁ Melotte 15

Tom McCrorie, Prestwick, South Ayrshire, UK, September 2024 and August–September 2025

Tom says: "This open cluster has always intrigued me and is one of my favourite objects to image. From the colours to the details, it will never cease to amaze me. I'm super happy with the final image."

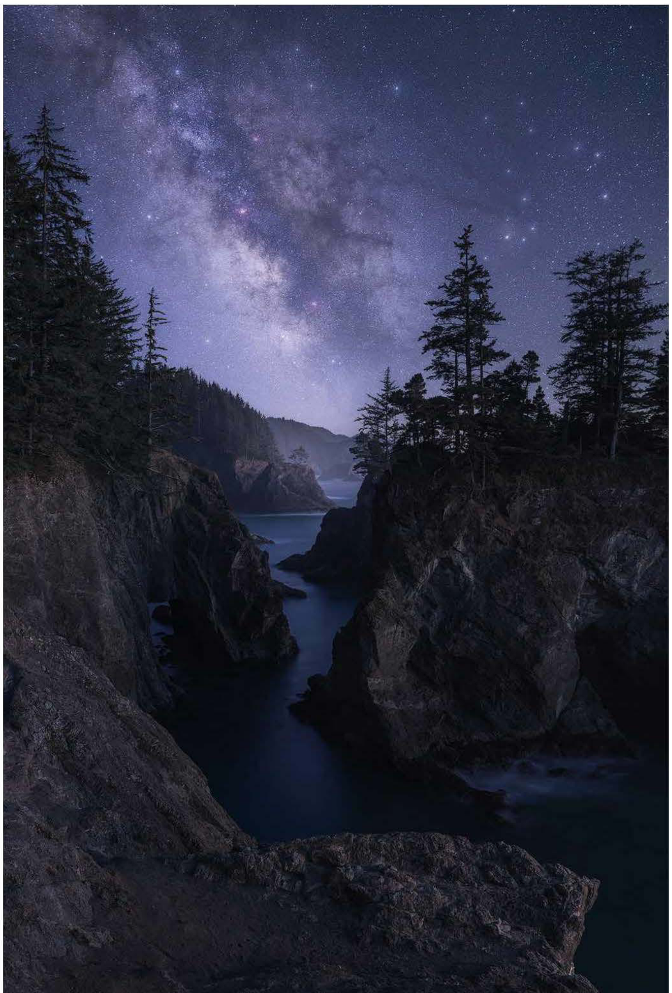
Equipment: ZWO ASI533MM Pro camera, Sky-Watcher Explorer 200P Dobsonian, ZWO AM5 mount **Exposure:** 24h total **Software:** PixInsight, Photoshop

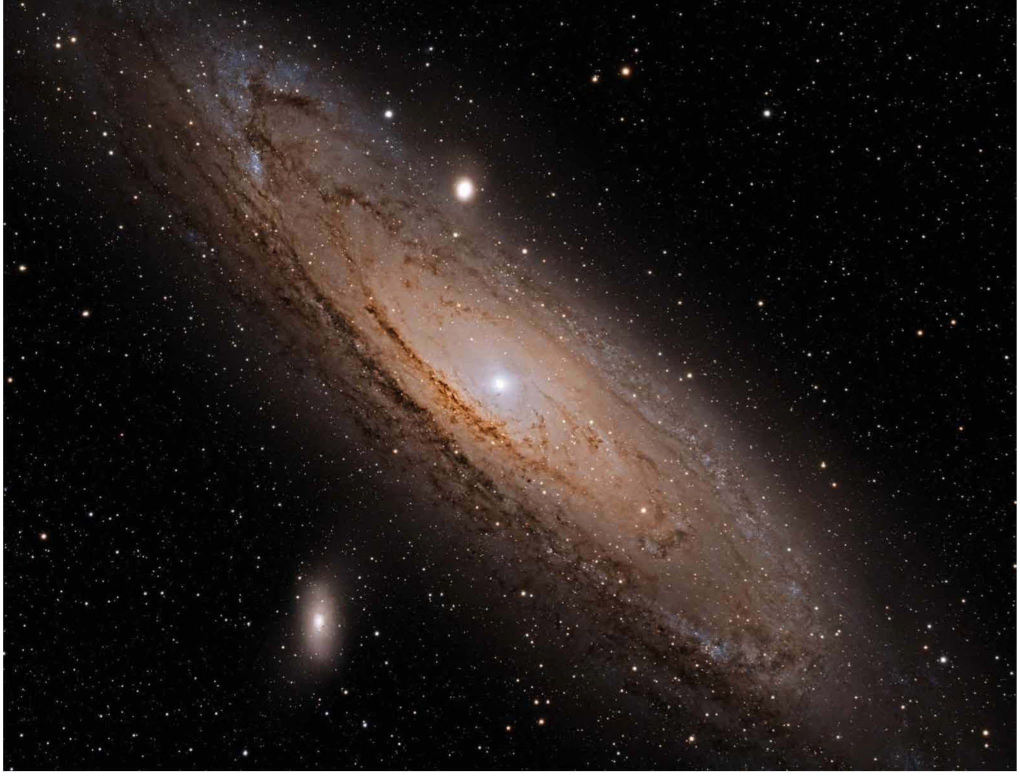
The Milky Way over Oregon ▷

Jeff Doyle, Samuel H Boardman State Scenic Corridor, Oregon, USA, 15 October 2020

Jeff says: "The Milky Way unfolds above the rugged cliffs of the Oregon coast, casting an ethereal glow that softens the rawness of the terrain. Silence is sacred here, punctuated only by the distant crash of waves."

Equipment: Canon EOS R camera, Canon EF 16–35mm lens, Really Right Stuff tripod **Exposure:** Milky Way ISO 12,800 f/4, 13"; foreground ISO 250 f/11, 30" **Software:** Starry Landscape Stacker, Photoshop





◁ The Andromeda Galaxy

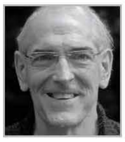
Zeno Foderaro, Sagna Rotonda, Piedmont, Italy, 23 August 2025

Zeno says: "Andromeda has always fascinated me, but I've found it tricky to capture. I finally succeeded, 1,700 metres up in the Italian Alps, under pristine skies, using no filters."

Equipment: Tecnosky Vision 571C, Tecnosky FPL55 90/540 OWL refractor, iOptron CEM26 mount **Exposure:** 91x 240" **Software:** PixInsight, Photoshop

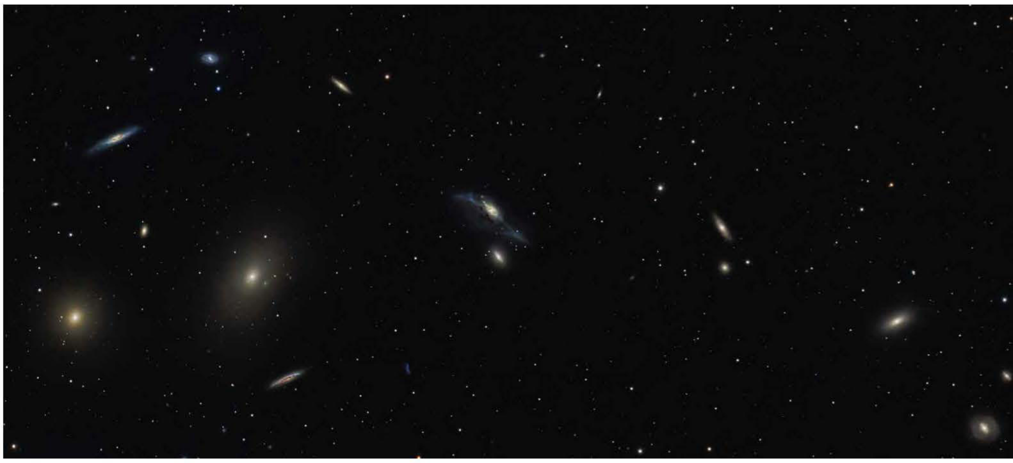
Markarian's Chain ▷

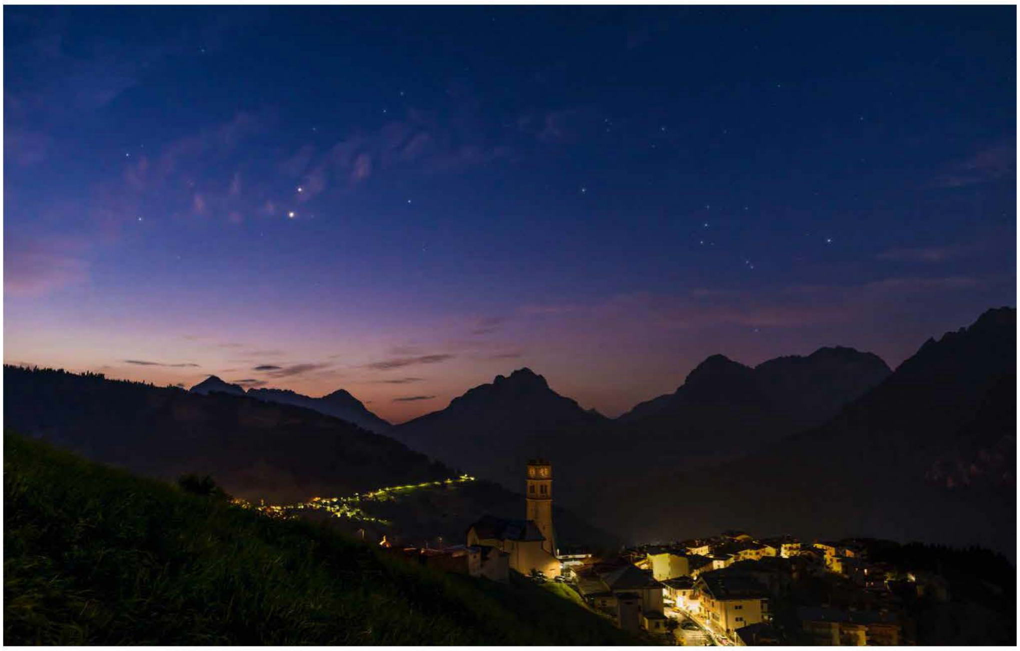
Patrick Cosgrove, Honeoye Falls, New York, USA, 22 and 27 April 2025



Patrick says: "With my new four-pier observatory completed during galaxy season, I was seeking a target for my widefield FRA400 scope – and Markarian's Chain is a great group!"

Equipment: ZWO ASI1600MM Pro camera, Askar FRA400 72mm refractor, ZWO AM5 mount **Exposure:** L 32x 120", R 34x 120", G 34x 120", B 41x 120" **Software:** PixInsight, Photoshop





◁ Venus and Jupiter over the Dolomites

Giorgia Hofer, Danta di Cadore, Veneto, Italy, 14 August 2025

Giorgia says: "Conjunctions are the events I love most, and dawn that day gave me a truly exceptional palette of colours, with the clouds glowing pink and the sky slowly turning orange."

Equipment: Nikon D750 camera, Sigma 24–35mm lens, Benro IT25 tripod **Exposure:** Sky ISO 1000 f/3.2, 2"; landscape ISO 1000 f/3.2, 1" **Software:** Photoshop

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Whether you're a seasoned astrophotographer or a beginner just starting out, we'd love to see your images. Send them to us at www.skyatnightmagazine.com/send-us-your-astrophotos

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86

Fast, a fiend for faint fuzzies – and fun! Is the Vespera Pro the smart scope to beat? We find out

VESPERA PRO

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★★★☆☆ Good ★★☆☆☆ Average ★☆☆☆☆ Poor/avoid

Vaonis Vespera Pro smart telescope

Swift, effortless and seriously capable – this scope makes every session count

WORDS: CHARLOTTE DANIELS

Smart telescopes have opened a new, accessible avenue for newcomers to astronomy, providing an all-in-one platform for capturing those first stellar photons. The Vaonis Vespera Pro is the latest model in the Vespera line and builds on the features of its predecessor, the Vespera II.

While the aperture and focal length are the same, the Vespera Pro boasts the larger Sony IMX676 colour sensor, which offers 12.5MP resolution versus the Vespera II's 8.3MP. The pixel size of 2μm means a sampling rate of 1.6 arcseconds per pixel, which is perfect for average seeing conditions, so we were keen to see what details we could capture.

We received the Cosmic Bundle, which meant that in addition to the hard case and tripod that come as standard, we also received a Vaonis dual-band filter and CLS light-pollution filter. Vaonis also sent us its solar filter, which does not come as part of the Cosmic Bundle but can be purchased separately.

The Vespera Pro's design couldn't be simpler: a single button and port on a sleek white unit. Once we'd assembled the tripod and screwed it into the unit's base, we downloaded the Singularity app (available for iOS and Android) and were ready to go.

The summer days didn't disappoint and we were soon granted an opportunity to use the solar filter. Bringing the Sun into the Vespera Pro's field of view was easy: after opening the arm, we selected Solar Mode in the app and popped the filter on before following prompts to level and aim the Vespera Pro. It then effortlessly slewed to and centred our nearest star and we captured some lovely sunspot details. At the time of review, via the app we could only save solar images as JPEGs; for solar and lunar imaging, TIFF files weren't available during our review. We felt this would be beneficial when it comes to stacking in processing software. We'd love to see video imaging as an option in future, to really boost details.

To the Moon and beyond

Our first clear night fell on a near-full Moon, providing a chance to test the Vespera Pro's lunar imaging. After opening the arm, we selected 'Initialise', which is the telescope's orientation and autofocus routine. This takes a little under five minutes to complete, ▶

VITAL STATS

- **Price** £3,089 Cosmic Bundle with filters; €2,490 basic package with tripod
- **Optics** Quadruplet apochromatic refractor
- **Aperture** 50mm
- **Focal length** 250mm
- **Sensor** Sony IMX676
- **Mount** Motorised altaz Go-To
- **Storage** 225GB built-in
- **Ports** USB-C, Wi-Fi
- **App control** Vaonis Singularity
- **Extras** Cloth bag, CLS filter, dual-band filter, lens cap, hard case
- **Weight** 5kg
- **Supplier** Vaonis
- **Tel** +33 4 84 98 00 21

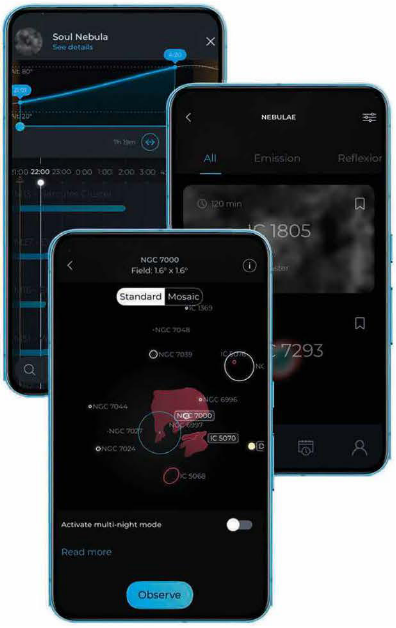
No rigmarole, all reward

Everything about the Vaonis Vespera Pro is designed to demystify astrophotography yet return exceptional imaging results that are worthy of more complex setups. At its heart is Vaonis's Singularity app, which works smoothly with the smart telescope.

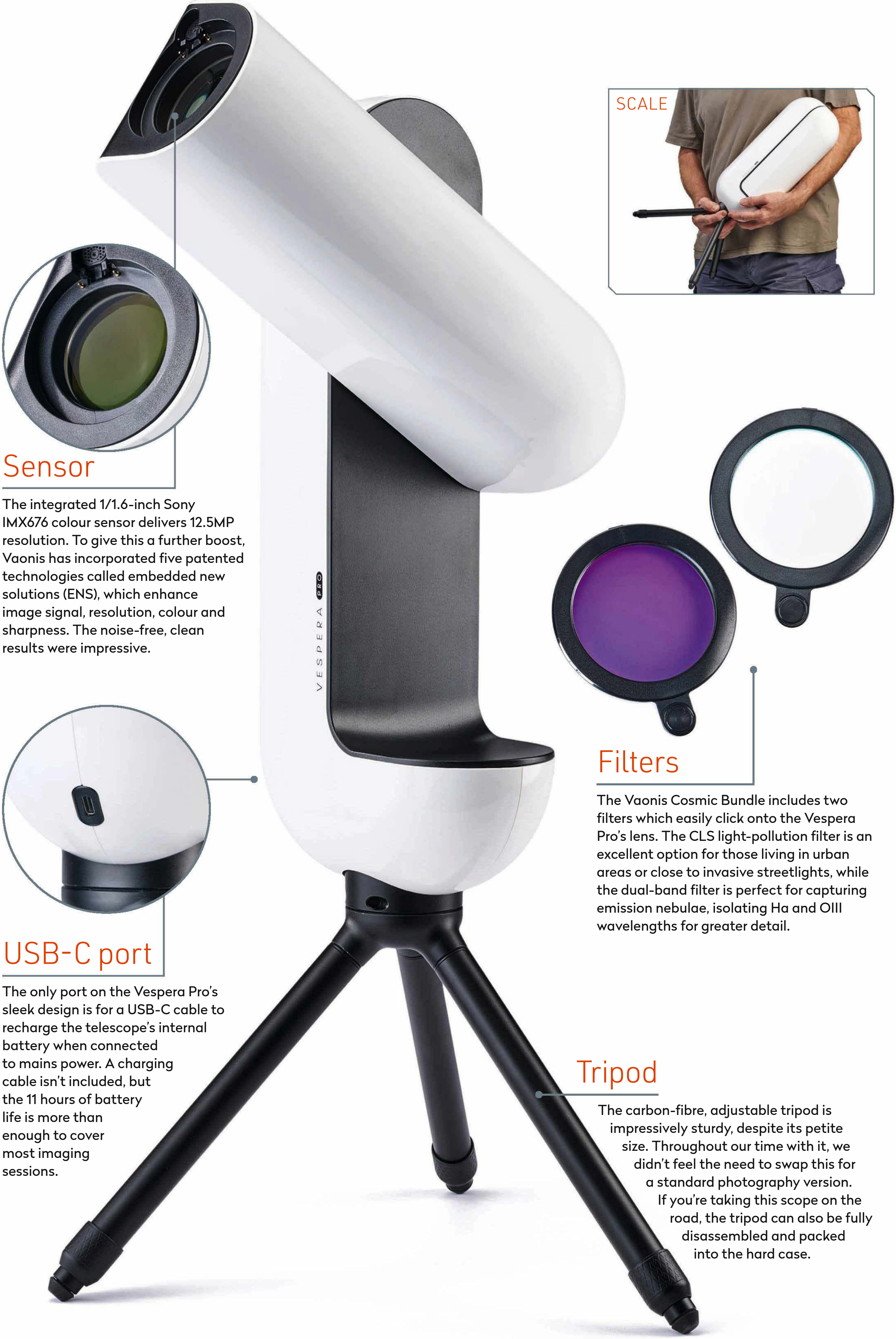
It takes five minutes from switch on to begin capturing a target. Singularity's Explorer feature is incredibly intuitive, allowing you to instantly see which targets are visible from your location. Simply choose an object and select 'Observe', or pick 'Advanced' to specify a particular region.

The 'Plan my Night' function lets you to organise your imaging session in advance and provides the times and visibility of targets, so you can prepare to capture multiple objects. It even provides recommended observation times for your selections, so you can be sure you're using every minute of clear sky.

For deep-sky objects, there are plenty of options as you gain confidence and broaden your imaging horizons. Expert Mode allows control over the camera settings, while there's also a Mosaic option for larger targets.



@THESHED_PHOTOSTUDIO X 5 | VAONIS X 3



Sensor

The integrated 1/1.6-inch Sony IMX676 colour sensor delivers 12.5MP resolution. To give this a further boost, Vaonis has incorporated five patented technologies called embedded new solutions (ENS), which enhance image signal, resolution, colour and sharpness. The noise-free, clean results were impressive.

USB-C port

The only port on the Vespera Pro's sleek design is for a USB-C cable to recharge the telescope's internal battery when connected to mains power. A charging cable isn't included, but the 11 hours of battery life is more than enough to cover most imaging sessions.

Filters

The Vaonis Cosmic Bundle includes two filters which easily click onto the Vespera Pro's lens. The CLS light-pollution filter is an excellent option for those living in urban areas or close to invasive streetlights, while the dual-band filter is perfect for capturing emission nebulae, isolating Ha and OIII wavelengths for greater detail.

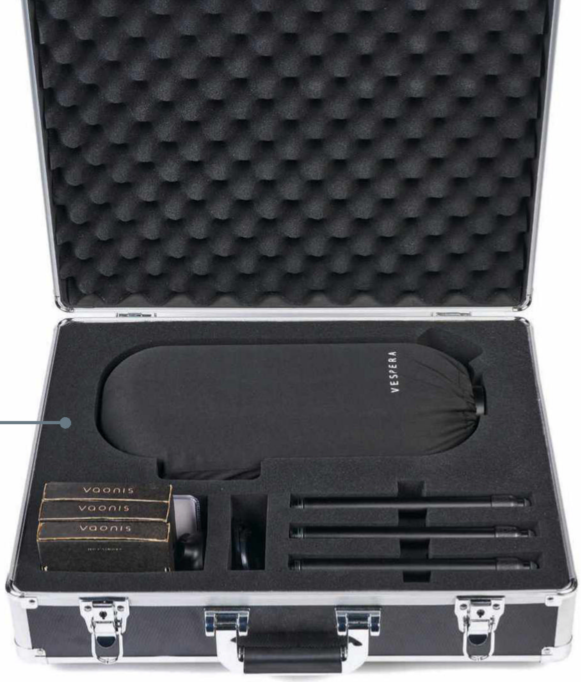
Tripod

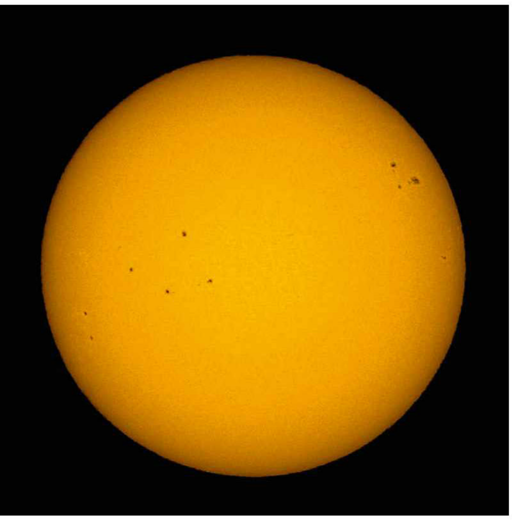
The carbon-fibre, adjustable tripod is impressively sturdy, despite its petite size. Throughout our time with it, we didn't feel the need to swap this for a standard photography version. If you're taking this scope on the road, the tripod can also be fully disassembled and packed into the hard case.

FIRST LIGHT

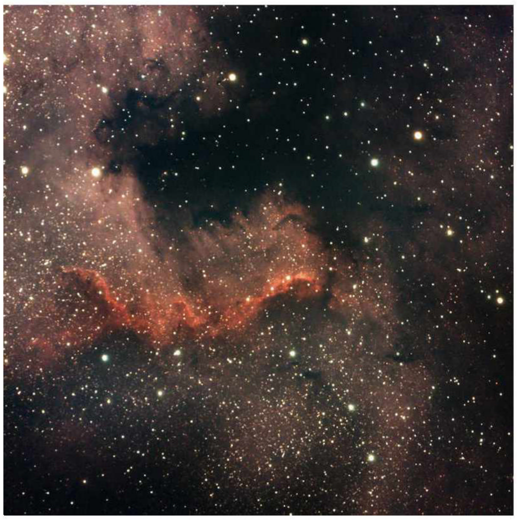
Carry case

A robust hard carry case is included to provide ample protection for the Vespera Pro, its tripod and accessories in transit, while a padlock is provided for extra safekeeping. The protective sleeve also ensures the unit is kept free from scratches, and a click-on dust cap keeps the lens clean.

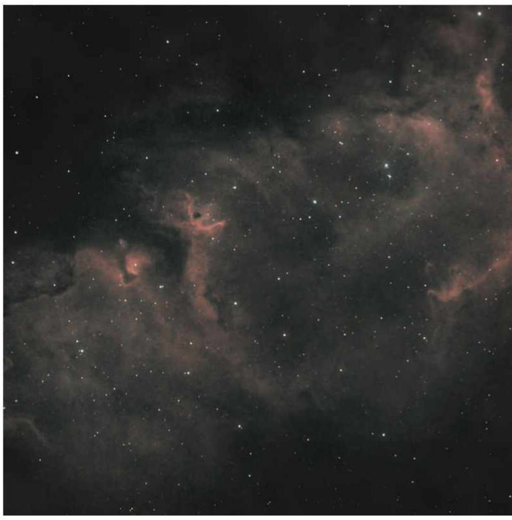




▲ Sunspot shots were simple with the Singularity app and optional solar filter



▲ Our North America Nebula, 442x 10", was so clean and noise-free that Photoshop edits were a breeze



▲ Processed Soul Nebula: Expert Mode with the dual-band filter, 255x 20"

▶ after which we could scout the skies. We selected the bright Moon and took a few snaps. While the autofocused results were crisp and clear, video and TIFF options would again be beneficial.

Next we tested it on the North America Nebula, NGC 7000, without a filter. Using default settings, we started our imaging session and enjoyed seeing the target quickly come to life via the app's live-stacking screen. Over the course of 75 minutes – the kind of session where dew can easily creep in – the Vespera Pro's integrated dew sensor and heater quietly kept the optics clear. We saved the stacked image as a TIFF and soon opened it in Photoshop. We were seriously impressed with the clean, low-noise image, which made making our processing tweaks a breeze.

A second clear night soon beckoned and this time we clipped on the dual-band filter. The app instantly detected it, initialising and focusing without any issues. Our target of choice was the Soul Nebula, IC 1848, for which we experimented with the camera settings in the app's Expert Mode. The Vespera Pro slewed effortlessly to our target and started its imaging run. Again, we loved seeing it gradually take shape on the app's live-stacking screen, despite being a much fainter object. We barely managed 90 minutes on this target due to unforeseen cloud, but even so were delighted when reviewing the data in Photoshop. Towards the end of our time with the Vespera Pro, we had discovered a new enthusiasm for ad hoc, unplanned imaging sessions, knowing that we were able to quickly take advantage of even an hour's clear skies.

The Vaonis Vespera Pro has been incredibly well designed for deep-sky photography. While we'd welcome a video option for lunar and solar images, we were too busy having fun capturing fainter and fuzzier objects to mind. It produces clean imaging results that make additional post-processing a pleasure. Whether you're chasing nebulae on a summer night or capturing galaxies in the darker seasons, this smart scope feels built to keep delivering every time you set it up.

KIT TO ADD

1. Vaonis clip-in solar filter

2. Vespera backpack

3. 30W, 5V–20V power supply, USB-C type

VERDICT

Build & design	★★★★☆
Ease of use	★★★★★
Features	★★★★☆
Go-To/tracking accuracy	★★★★★
Imaging quality	★★★★☆
OVERALL	★★★★☆

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Bresser PushTo AR-80/400 smart telescope with tripod

This bargain app-assisted starter set takes you from box to stars in minutes

WORDS: JIM OWEN

VITAL STATS

- **Price** £259
- **Optics** 80mm achromatic refractor
- **Focal length** 400mm, f/5
- **Mount** Manual altazimuth with slip clutch
- **Extras** Tripod, solar filter, 2x Barlow, 6mm and 20mm eyepieces, smartphone holder, compass
- **Weight** 4.3kg
- **Supplier** Bresser UK
- **Tel** 01342 837098
- **www.** bresseruk.com

@THESHED_PHOTOSTUDIO X 5 | BRESSER

Astronomy has always carried a certain mystique. For many, it feels like an intimidating hobby, steeped in technical jargon and reliant on complex equipment. The new Bresser PushTo AR-80/400 smart telescope sets out to dispel that reputation. Combining classic refractor optics with a manual mount and an app-based navigation system, it positions itself as a beginner's gateway to the cosmos. Over several evenings – and a daytime solar session – we put it through its paces.

The scope arrived from Bresser UK in one tightly organised package. Setup was delightfully straightforward, with just two bolts to connect the mount head to the tripod. Within 10 minutes we were ready for first light. We noted that while the lightweight tripod is perfectly serviceable, the telescope can also rest sturdily on its tabletop mount for more spontaneous grab-and-go moments. This flexibility makes it well suited to garden observing, travelling to darker sites, or even positioning by a window when a gap in the clouds appears.

Bresser has been generous with the accessory bundle, providing two eyepieces (6mm and 20mm), one 2x Barlow lens, a solar filter, smartphone holder, compass and a detailed instruction manual. It's more than enough to get you started without feeling the need to add extras from day one. If we had a minor gripe, it was with the eyepiece markings: the black lettering on a black background is difficult to read by torchlight. Still, this feels like nitpicking when considering the set's overall value.

The heart of the push-to system lies in the companion app, which connects via Bluetooth. Installation was smooth, although it's worth noting that at the time of review no iOS version was available. Our review model paired happily with a Windows 10 laptop within minutes. Once configured, the app acts as your digital guide, helping you align the mount and select targets with simple step-by-step cues.

First test: the Sun

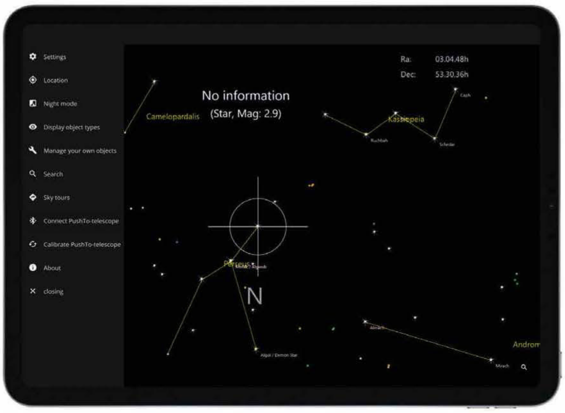
Before heading for the stars, we gave the telescope a shakedown during the day, using the included solar filter for a safe look at the Sun. With the 20mm eyepiece in place, its pale disc was revealed in crisp detail, with small sunspots punctuating the surface. ▶

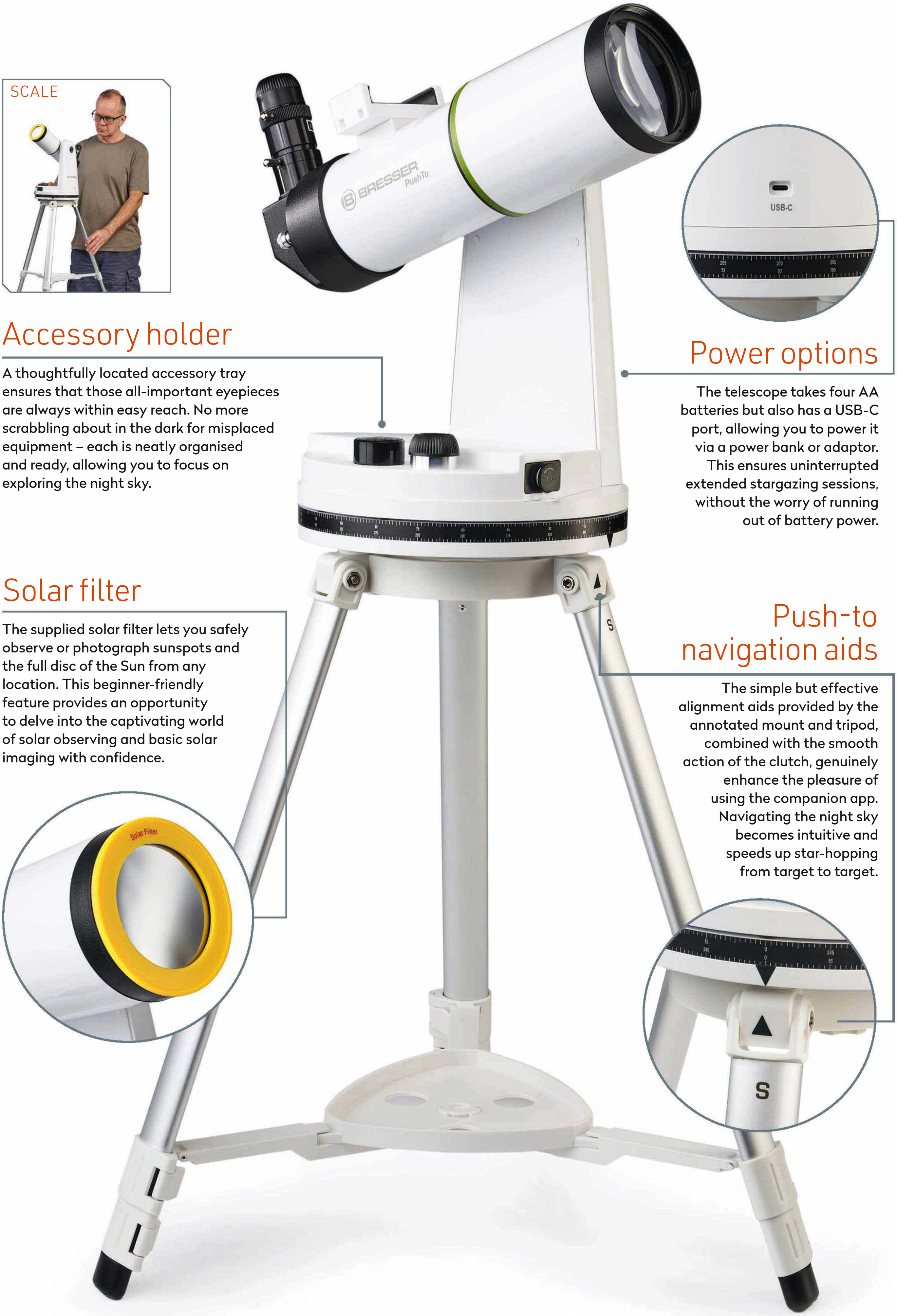
Smart help when you need it

The standout feature of the Bresser PushTo AR-80/400 is its blend of traditional manual control with the navigation abilities of the PushTo app. Unlike Go-To systems, this hybrid approach keeps things simple and costs low.

The Bluetooth connection unlocks accurate target location without the frustration of motors or cables, allowing you to easily swing the scope by hand and instantly track down objects. Our favourite part of the PushTo app is the constellation maps: they're clear, uncluttered and easy to follow, helping beginners build a solid sense of orientation. It's a great example of a 'bridge' solution: a scope that teaches you the sky rather than doing all the work for you – but offering plenty of smart help when you want it.

Assisting – not replacing – the classic joy of star-hopping, makes the Bresser PushTo AR-80/400 unique at its price point and a brilliant option if you're unsure whether to go fully manual or embrace smart technology at the start of your astronomy journey.





Accessory holder

A thoughtfully located accessory tray ensures that those all-important eyepieces are always within easy reach. No more scrabbling about in the dark for misplaced equipment – each is neatly organised and ready, allowing you to focus on exploring the night sky.

Power options

The telescope takes four AA batteries but also has a USB-C port, allowing you to power it via a power bank or adaptor. This ensures uninterrupted extended stargazing sessions, without the worry of running out of battery power.

Solar filter

The supplied solar filter lets you safely observe or photograph sunspots and the full disc of the Sun from any location. This beginner-friendly feature provides an opportunity to delve into the captivating world of solar observing and basic solar imaging with confidence.

Push-to navigation aids

The simple but effective alignment aids provided by the annotated mount and tripod, combined with the smooth action of the clutch, genuinely enhance the pleasure of using the companion app. Navigating the night sky becomes intuitive and speeds up star-hopping from target to target.

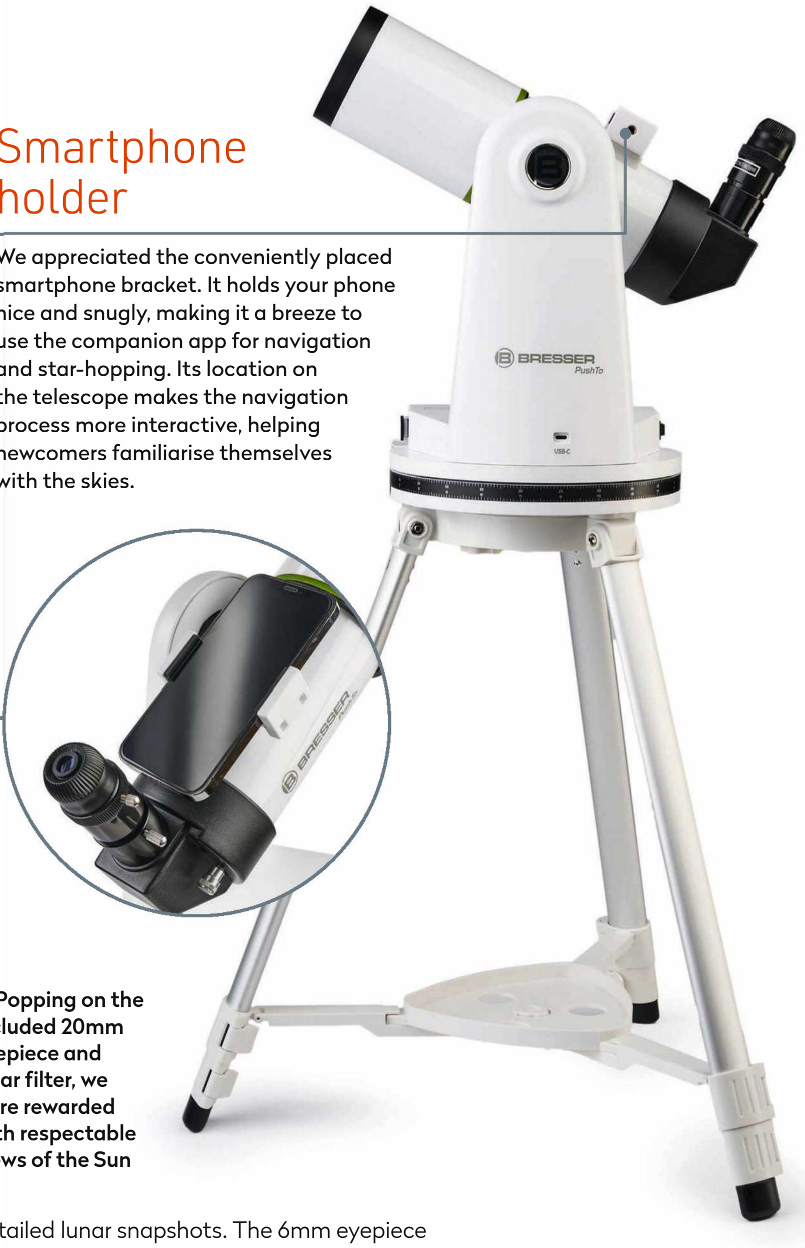
FIRST LIGHT

▲ Moon views were delightfully crisp and contrast-rich, with the phone holder making it easy to grab some pics

◀ Popping on the included 20mm eyepiece and solar filter, we were rewarded with respectable views of the Sun

Smartphone holder

We appreciated the conveniently placed smartphone bracket. It holds your phone nice and snugly, making it a breeze to use the companion app for navigation and star-hopping. Its location on the telescope makes the navigation process more interactive, helping newcomers familiarise themselves with the skies.



▶ Attaching a smartphone was remarkably painless thanks to the smartphone holder. A quick shield from stray light with a cupped hand improved contrast further, and before long we were snapping respectable solar images.

Nightfall revealed more. With the compass and marked tripod leg making alignment nearly idiot-proof, we were soon scouring the Milky Way with ease. The f/5 optics served up wide, starry fields with pleasing sharpness. Jumping from one constellation to another using the app's guided tour was intuitive, quickly becoming second nature. For someone encountering the night sky for the first time, this digital handholding is invaluable.

With a short-focus refractor, there were inevitable traces of chromatic aberration, with slight purple fringing on bright stars, but never distracting enough to spoil things. Learning the right 'push' with the manual mount took practice, but was buttery-smooth once we got the feel, allowing fine corrections.

The highlight came in the early morning hours, when the Moon emerged high and clear. The 20mm eyepiece gave an expansive, contrast-rich view, showing crisp crater rims and the familiar sweep of the lunar maria. It remained our favourite, especially when paired again with the smartphone holder for detailed lunar snapshots. The 6mm eyepiece promised more magnification but proved fiddly, its narrow eye relief making comfortable viewing difficult.

What stands out most about the Bresser PushTo AR-80/400 is how effortlessly it marries simplicity with clever guidance. Beginners can be 'on the Moon' within minutes of unboxing, while those looking for a travel-friendly scope will appreciate its compact form.

For anyone making their first step into amateur astronomy, this is an appealing package. It combines a classic optical design with 21st-century ease of use, guiding you gently without overwhelming. No, it won't rival larger instruments for deep-sky performance, but that's not the point. Its role is to get you outside, looking up, with as little friction as possible. In that, it succeeds brilliantly.

VERDICT

Assembly	★★★★☆
Build & design	★★★★☆
Ease of use	★★★★☆
Features	★★★★☆
Optics	★★★☆☆
OVERALL	★★★★☆

KIT TO ADD

1. Bresser 40mm Plössl eyepiece

2. Explore Scientific ND 0.9 filter

3. Bresser Wi-Fi eyepiece camera with display

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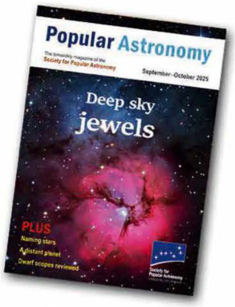
Editor wanted



The Society for Popular Astronomy requires an editor for *Popular Astronomy* magazine. This is a unique opportunity for anyone interested in a career in science journalism and outreach.

We need someone with a good knowledge of both professional and amateur astronomy, excellent writing skill, an eye for detail and an ability to meet bi-monthly deadlines. Remuneration (not astronomical!) to be discussed.

If you are interested please contact Robin Scagell at editor@popastro.com by 30 November 2025 with details of your background and any editorial experience. Please include an appropriate example of your original writing.

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Charlotte Daniels rounds up the latest astronomical accessories

GEAR

1

2

3

4

5

6

1 Baader Polaris measuring and guiding eyepiece

Price £95 • **Supplier** The Widescreen Centre
www.widescreen-centre.co.uk

This illuminated 25mm eyepiece has a fold-down rubber eyecup and built-in reticule to speed up the setup process for astrophotography perfection. Use it to perform a precise star alignment or to identify stars for autoguiding to keep your mount on track.

2 ToupTek StellaVita smart controller

Price £335 • **Supplier** Altair Astro
www.altairastro.com

ADVANCED Astrophotography setups are becoming so complex, with different software and hardware requirements to manage filter wheels, focusers, cameras and guiding equipment. This wireless 'astrostation' ensures your devices can connect seamlessly and comes pre-installed with astrophoto-capturing software.

3 Moon phase blanket

Price £39.95 • **Supplier** Heritage House
www.heritagehousegb.co.uk

The nights are getting colder! When clouds get in the way of astronomy, nights on the sofa under a warm blanket beckon. Made from 100 per cent cotton, this 130cm x 160cm throw is machine washable and decorated with phases of our natural satellite.

4 Ceramic Moon and stars coasters

Price £15.99 • **Supplier** Gngcoastline
www.gngcoastline.co.uk

This set of four terracotta coasters, each measuring about 105mm square, are handmade and feature eye-catchingly bright stars and crescent Moons. Add them anywhere in your home for a pop of bold colour while protecting surfaces from hot cups or dishes.

5 Kenko Skymemo S portable tracking platform

Price £245 • **Supplier** Bristol Cameras
www.bristolcameras.co.uk

Tracking mounts keep your targets centred in the field of view. This lightweight platform lets you polar align for long exposures. Pick the star symbol for deep-sky objects, or the Sun or Moon for solar or lunar imaging.

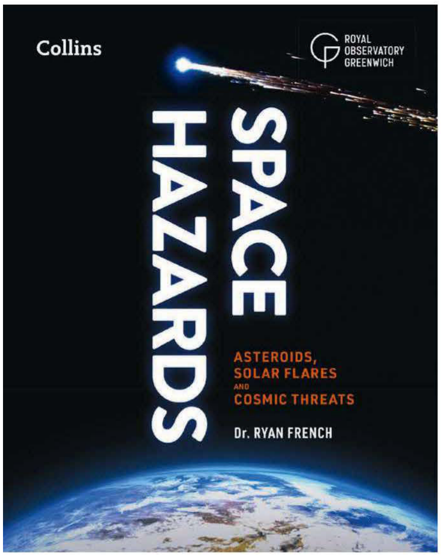
6 Lego Earth and Moon orbit model

Price £69.99 • **Supplier** Lego • **www.lego.com**

This interactive kit includes 526 pieces and is perfect for teaching young stargazers about our Solar System. Assemble the gear elements and turn the crank to see how the Moon and Earth orbit the Sun. Suitable for ages 10 and up.

New astronomy and space titles reviewed

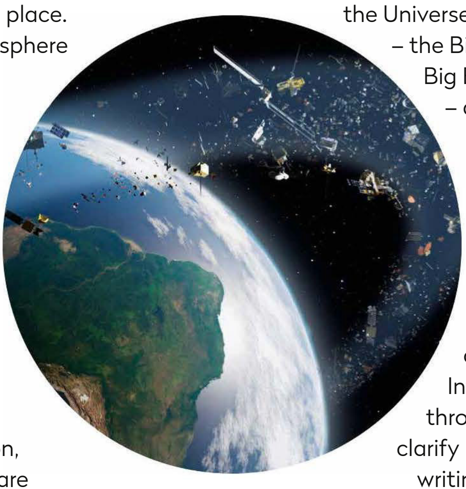
BOOKS


Collins
ROYAL OBSERVATORY GREENWICH
SPACE HAZARDS
ASTEROIDS, SOLAR FLARES AND COSMIC THREATS
Dr. RYAN FRENCH

Space Hazards

Ryan French
Collins
£20 ● HB

Space is a dangerous place. Though Earth's atmosphere and magnetic field afford us some protection, we're still vulnerable to solar flares, geomagnetic storms, incoming asteroids or comets, and falling space junk.


Space junk, from defunct satellites to lost astronaut tools, may one day trap us on Earth

Space Hazards explores all these threats, from common, disruptive events to rare but devastating extinction-level catastrophes. Risk levels in each category are clearly laid out in tables, while the missions to monitor and mitigate these dangers are covered too.

The opening chapter on the Sun and space weather sets the tone. The solar flare observed by Richard Carrington in 1859 released a powerful coronal mass ejection that caused widespread disruption to telegraph systems. Imagine the devastation of such an event today, given our reliance on electronic and computer systems. The chapter on space junk is particularly sobering. There are over 9,000 active satellites in orbit around our planet, nearly 7,000 of which are Starlink satellites operated by SpaceX. Some 37,000 large pieces of space debris are currently being tracked, and it's possible we could lose access to space altogether – unable to launch anything through an impenetrable barrier of space junk – by the second half of this century. We may be imprisoning ourselves on the surface of Earth.

Changes in Earth's orbit and Milankovitch cycles that affect our weather patterns are well explained, along with magnetic field variations and the crystallisation of Earth's core. The book even touches on potential dangers from beyond our Solar System, in the form of extraterrestrial life, whether microbial or intelligent civilisations. Theories about the Universe's eventual fate – the Big Rip, Big Crunch, Big Bounce or Big Freeze – are also explored.

The book is well laid out and illustrated with some stunning images, and the science behind the hazards is clearly explained. Interesting boxouts throughout help to clarify key points. The writing strikes a good balance between clarity and friendliness, though a few grammatical and typographic errors have crept in.

This is not a book for the faint-hearted, but it's highly recommended for anyone interested in space and the dangers that lurk there. ★★★★☆

***Jenny Winder** is a science writer and broadcaster*

MARK GARLICK, SCIENCE PHOTO LIBRARY, GETTY

Interview with the author

Ryan French

What are the biggest threats within our Solar System?

Space weather and near-Earth objects (NEOs) are the most prominent natural threats. Space weather is the influence of solar activity on our technological infrastructure, and NEOs are asteroids and comets passing close enough to pose a risk of collision. These are joined by a threat of our own creation: space junk, which may leave low-Earth orbit unusable.

Should we worry about solar storms?

Like Earth-based natural disasters, they're worth monitoring, but not losing sleep over. In May 2024, an extreme solar storm triggered overheating alarms across the UK national grid, and a loss in satellite navigation caused a $500 million disruption to US agriculture. Earlier events caused widespread power outages in Canada (1989) and South Africa (2003). Yet each year, we become better prepared for the largest solar storms – last experienced in 1859 – which occur every one to two centuries.

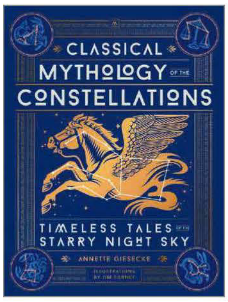
What about threats from beyond our Solar System?

Such threats pose a risk over timescales of hundreds of millions of years. Within this timeframe, nearby stars will likely go supernova, disrupting Earth's ozone layer and threatening our habitable atmosphere. In a few billion years, our Galaxy will collide with Andromeda. During this merger, passing stars will disrupt the Kuiper Belt and Oort cloud, sending comets into the inner Solar System and subjecting Earth to hundreds of millennia of bombardment.

***Ryan French** is a solar physicist, science communicator and author*

Classical Mythology of the Constellations: Timeless Tales of the Starry Night Sky

Annette Giesecke and Jim Tierney
Black Dog & Leventhal
£25 ● HB



When we gaze up at the night sky, we're often motivated by a scientific desire to know and understand more about the objects we see. But to look at the sky is also to look into the past – not just of the Universe, but of human culture. Ancient peoples saw patterns in the stars and placed their gods among them, and the myths tied to these constellations remain enthralling to us to this day.

This new guide to the mythology of the constellations is written by the renowned classicist Annette Giesecke and focuses on the rich stories from ancient Greece and Rome. It's beautifully produced and illustrated not with scientific images, but with evocative depictions of the Greek gods, heroes and heroines, and fantastical animals such as winged horses and sea monsters – all created by illustrator Jim Tierney.

For each constellation, there's a summary of the myth associated with it, accompanied by an illustration with an overlay of stars. Astronomers might associate Orion with bright stars Betelgeuse and Rigel and its famous nebula; here, Orion appears as a hunter carrying a lion's pelt. One minor drawback to this constellation-by-constellation approach is that many myths are interconnected. For example, Andromeda, Cepheus, Cassiopeia and Perseus all feature in the same myth of Andromeda being chained to a rock as a sacrifice for her mother Cassiopeia's pride, before she is rescued by Perseus. So inevitably, there is some repetition.

Forty-eight of the constellations were defined nearly 2,000 years ago by the Greco-Roman astronomer Ptolemy and are still in use today. The remaining 40, mostly found in the Southern Hemisphere, are more recently defined. They don't have ancient Greek or Roman myths associated with them, and are covered more briefly towards the end of the book.

The book also includes maps of each celestial hemisphere and brief practical advice on when to view each constellation, and the latitude range at which it's visible. Every constellation has a quote from a relevant ancient source, such as the Roman author Ovid, and there's also a glossary of these sources for readers keen to delve further.

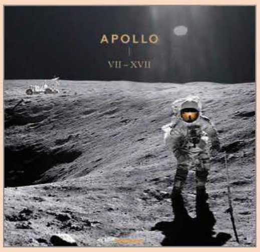
This book is a great counterpart to scientific guides and would make a fantastic introduction to the world of mythology for younger readers.
★★★★☆

***Pippa Goldschmidt** is a science and astronomy writer*

Apollo VII–XVII

APOLLO PHOTOS

Floris Heyne, Joel Meter, Simon Phillipson and Delano Steenmeijer
teNeues
£49.95 ● HB



Five decades on from when humans last left their footprints on the Moon, it's hard for anyone born since 1972 to visualise Apollo through anything but the mottled lens of history. It belongs to a bygone era, a turbulent time when youth counterculture, war in Vietnam, East–West tensions, civil rights struggles and the Moon Race all jostled for front-page primacy.

Today, Apollo is dimly glimpsed through oral histories, vintage films and the art of photography, that ubiquitous medium that's said to tell a thousand words. This is especially true of *Apollo VII–XVII*, a beautiful photographic portrait of our first foray to another world, captured in iridescent colour and striking monochrome.

First published in 2021, this edition is newly revised and expanded, and features breathtaking images from the 11 Apollo flights between 1968 and 1972 that sent astronauts beyond Earth for the first time.

We see Ed Mitchell, almost lost in the darkness at Fra Mauro, Charlie Duke trudging across the lonely Descartes highland plains, and Jack Schmitt drinking in the scenic splendour of the Taurus–Littrow valley. Walt Cunningham squints against harsh sunlight, and Gene Cernan, filthy with lunar grime, grins through whiskers and tired eyes after a Moonwalk.

Apollo 8's Bill Anders said that the most surprising thing about visiting the Moon was seeing Earth for the first time. It's fitting, then, that our colourful oasis of life snatches its fair share of page space here. This is as much a tale about Earth, the journey through space and the human experience as it is about the Moon. Colour infuses the early pages, then fades as the book progresses – a reminder of our Moon's muted tones. Yet even its grey-tan hue is tinged with colour: the US flag, gold insulation on the lunar module, the blue-and-white marble of Earth.

The reader is teased with images of the Moon's haunting loneliness, the unreal clarity of its untouched, lifeless landscape forced into stark relief by its lack of an atmosphere and harsh, unfiltered sunlight.

Apollo VII–XVII is a book of photographs, to be sure, but within its pages are images selected with such care, and processed with such keen precision, that it's difficult to scroll through them without pausing for thought – and just as hard to put down.
★★★★★

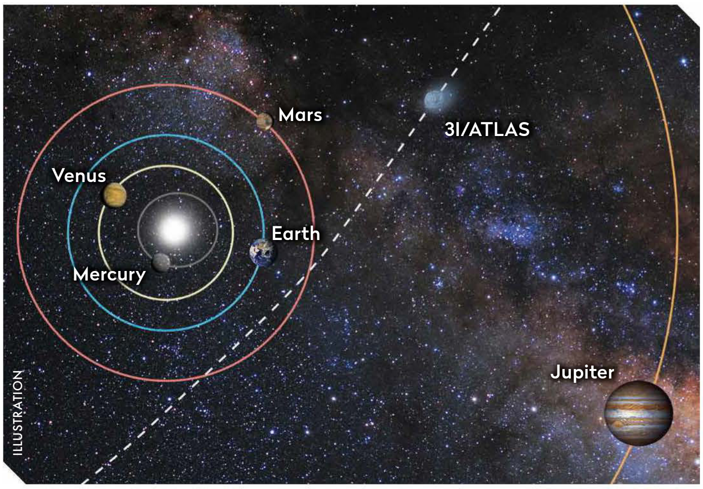
***Ben Evans** is the author of numerous books on spaceflight*

Anita Chandran talks to Dr Matthew Hopkins

Q&A WITH AN INTERSTELLAR OBJECT INVESTIGATOR

A seven-billion-year-old object has just entered our Solar System. We ask what comet 3I/ATLAS is doing here – and what it reveals about our Galaxy's past

What is 3I/ATLAS and what makes it so interesting?
3I/ATLAS is an interstellar object that was discovered passing through the Solar System by the Asteroid Terrestrial-impact Last Alert System (ATLAS) survey. During the survey, we built a simulation: the Ōtautahi–Oxford interstellar object population model. Among other things, this can tell us about the age of transiting bodies like 3I/ATLAS. I noticed that 3I/ATLAS was bobbing up and down on its orbit around the Milky Way, which was a lightbulb moment for me, because I knew that older stars also followed a similar pattern in their orbits. When we ran all the statistics and looked at the correlations, we found that 3I/ATLAS was probably over seven billion years old, about twice the age of our Solar System.



▲ The path of 3I/ATLAS ('I' stands for 'interstellar'), discovered in July – only the third such object ever detected, after 1I/'Oumuamua and 2I/Borisov

Why have we only discovered three of these interstellar interlopers?
They need to be close enough that they reflect enough sunlight for us to be able to see them. These objects don't tend to reflect a lot of light and tend to be very dark in colour. We also need to determine that the object is a moving point of light and not just something that appears in one image and is never seen again. So, asteroids and comets are generally difficult to find, and these ones that come from outside the Solar System are even harder. But there are a lot of them! Around 50 are predicted to be within the orbit of Jupiter at any time, but there are also around five million asteroids in that volume of space, so the numbers are stacked against us finding interstellar objects.

How do you distinguish an interstellar object from a Solar System asteroid?
When we see the object moving, we can work out what path it's taking. If something is bound to the Sun, its path will look like a circle or an ellipse. Interstellar objects have orbits that take a different form, which we call hyperbolic. This means they come in on a straight line, bend around the Sun and then leave again on a straight line.

NASA, JPL-CALTECH

Matthew Hopkins is a researcher at the University of Oxford, studing interstellar objects and galactic evolution

Are we likely to detect more of these objects soon?
The upcoming Vera C Rubin Observatory is going to make a big difference. It's going to conduct what's called the Legacy Survey of Space and Time (LSST), a 10-year survey of the southern sky. It's a very sensitive telescope, looking at huge areas of the sky.

How long will 3I/ATLAS be around for?
The timescale is months. We discovered it in July, when it was within the orbit of Jupiter, and it was only just visible then. Right now, it's going behind the Sun and is near its closest approach. In roughly a year, it will be fading from visibility for most of our telescopes.

What else can we learn from 3I/ATLAS?
It's a really interesting object. Its existence implies that there were planetesimals (or tiny planets) in the Galaxy a very long time ago. And what we know about the composition of 3I/ATLAS also tells us these planetesimals contained heavier elements than hydrogen and helium. Seven billion years ago, the Galaxy would have looked very different to how it does today. 3I/ATLAS is like seeing a piece of that earlier Universe in our lifetimes.

What's next for researchers?
We have to wait for 3I/ATLAS to emerge from behind the Sun [expected to be in early December]. After that, we'll start using our telescopes to understand how it evolves. Our team will be trying to look at its chemical composition, because that will tell us about its parent body. On a bigger-picture scale, we'll be anticipating the LSST survey by the Rubin Observatory, as this will help us to spot many more of these interstellar objects.

Could we spot it with an amateur telescope?
It's going to remain pretty faint throughout its passage through the Solar System, so will probably be out of reach of all but the biggest amateur telescopes. However, comets can be unpredictable and can undergo sudden increases in brightness due to bursts of activity, so we might get lucky!

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These European-made mounts come complete with a built-in Raspberry Pi-based control system, allowing for easy Plate Solving and GoTo control and also management of a wide range of cameras, autoguiders, focusers, filter wheels, and more - all without locking you into a specific manufacturer's product line. This puts the Nebula mount at the heart of your astrophotography rig - easily enabling sequencing of all aspects of your imaging.

Available in two sizes: the ultraportable Nebula 5 and the more capacious Nebula 6 - these mounts are now available to order.

Please see our website for more details.

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VSD90SS

LUNT LS40 DOUBLESTACK
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All prices correct at time of press. Subject to change. Errors and omissions excepted.

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153mm f/7.8 PARABOLIC DOBSONIAN
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THE SOUTHERN HEMISPHERE

With Glenn Dawes

Look out for the Leonids mid-month and meet 'the family' – the other galaxies in our local group

When to use this chart

1 Nov 00:00 AEST (31 Oct, 14:00 UT)
15 Nov 23:00 AEDT (12:00 UT)
30 Nov 22:00 AEDT (11:00 UT)

The chart accurately matches the sky on the dates and times shown for Sydney, Australia. The sky is different at other times as the stars crossing it set four minutes earlier each night.

NOVEMBER HIGHLIGHTS

The Leonids meteor shower has delivered spectacular displays of fireballs over the years. Being linked to the debris from periodic comet 55P/Tempel–Tuttle, it's at its best every 33 years when 55P returns to perihelion, the last being in 2001. This year, the Leonids are expected to be active 6–30 November, peaking on 18th. The radiant (in the Sickle of Leo) rises around 01:00. With a new Moon on 20th, its thin crescent shouldn't interfere with predawn observations.

STARS AND CONSTELLATIONS

The Milky Way belongs to the Local Group family of galaxies. Of the 80 or so members, three of the brightest are well placed to observe in November evenings. Low in the north lies the Andromeda Galaxy, M31. The Milky Way and M31 dominate the family. Andromeda is clearly visible to the naked eye from dark country skies, as are two satellite galaxies to the Milky Way: look high in the south to see the Clouds of Magellan, the small one (SMC) to the right of the larger (LMC).

THE PLANETS

Evening planet Mercury drops into the Sun's glare mid-month. Mars also drops into the west, spending November embedded in twilight. The Red Planet is overtaken by Mercury on 13th, with the planets closest at only 1.3°. Saturn, with Neptune a few degrees behind, remains well placed for evening observations, transiting as dusk ends. Uranus is at opposition in November and visible all night. Jupiter, now rising before midnight, still delivers its best views in the mornings.

DEEP-SKY OBJECTS

Currently passing overhead is the obscure constellation of Sculptor. The brilliant Silver Dollar Galaxy, NGC 253 (RA 0hr 47.5m, dec. –25° 17') is the central and brightest member of the Sculptor group of galaxies. This seventh-magnitude edge-on spiral (22 x 4 arcminutes) is visible in binoculars. A 150mm telescope shows a prominent elongated (7 x 2 arcminutes) core, brightening to a broad nucleus, with distinct mottling extending into the surrounding halo. This betrays fragments of its spiral arms. Larger instruments reveal a dark lane.

Head 1.7° southeast to the globular cluster NGC 288 (RA 0hr 52.8m, dec. –26° 35'). At eighth magnitude, this too is visible in binoculars. One of the more scattered globulars, a 200mm scope shows well-resolved stars evenly spread across its bright 5-arcminute core, extending out to its narrow halo (7 arcminutes across).

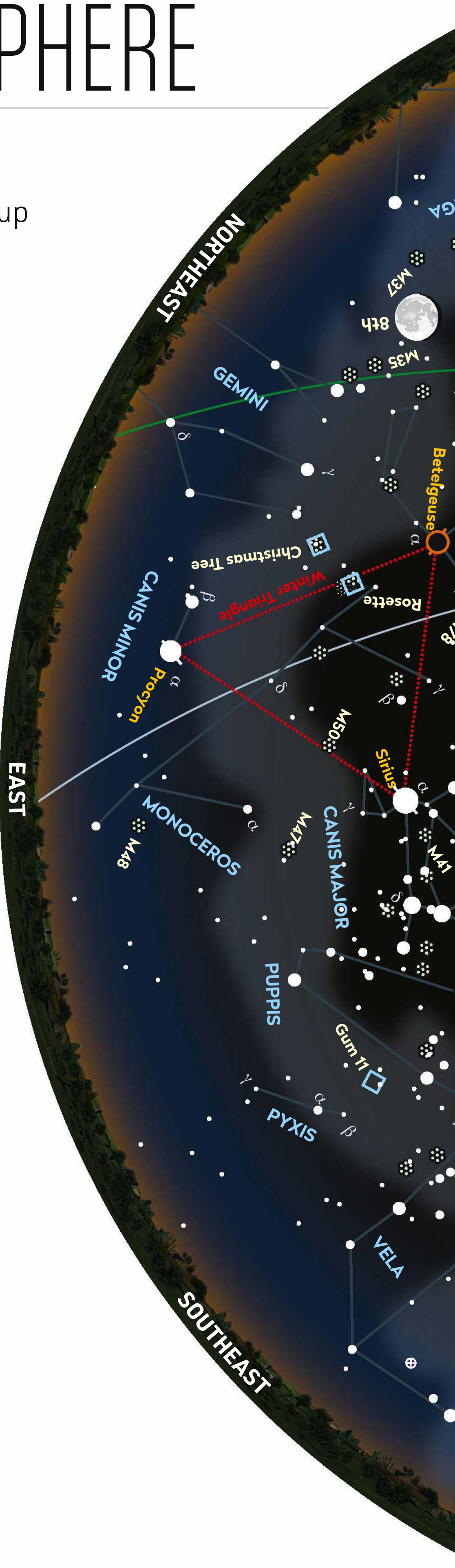
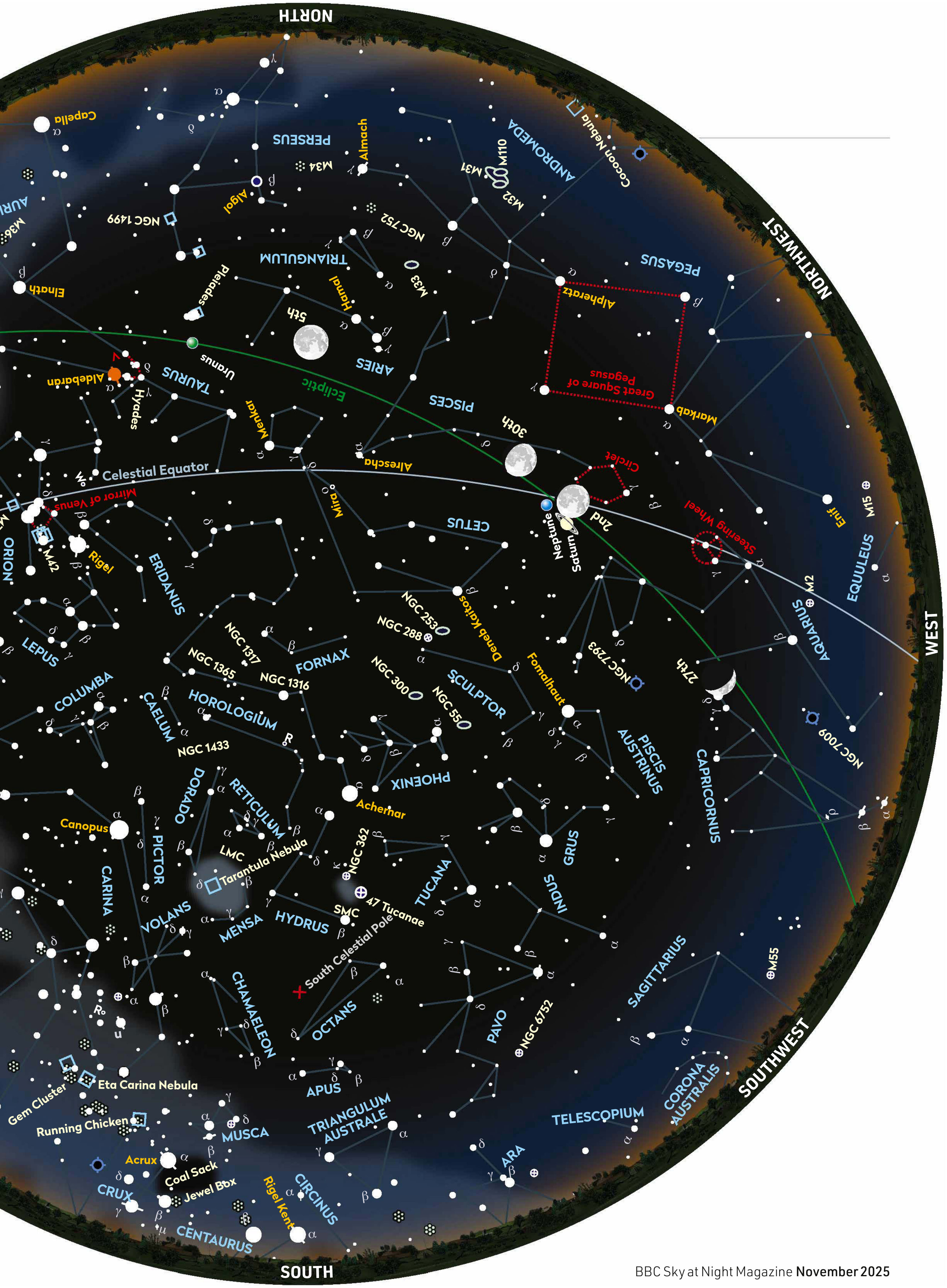


Chart key

- GALAXY
- OPEN CLUSTER
- GLOBULAR CLUSTER
- PLANETARY NEBULA
- DIFFUSE NEBULOSITY
- DOUBLE STAR
- VARIABLE STAR
- COMET TRACK
- ASTEROID TRACK
- METEOR RADIANT
- QUASAR
- PLANET

STAR BRIGHTNESS:
- MAG. 0 & BRIGHTER
- MAG. +1
- MAG. +2
- MAG. +3
- MAG. +4 & FAINTER

CHART: PETE LAWRENCE


NORTH
NORTHWEST
WEST
SOUTHWEST
SOUTH
Capella
PERSEUS
Almach
M34
Algol
NGC 1499
ANDROMEDA
Cocoon Nebula
M110
M31
M32
NGC 752
TRIANGULUM
M33
Hamal
Pleiades
Elnath
PEGASUS
Alpheratz
5th
ARIES
Uranus
Ecliptic
Aldebaran
TAURUS
Hyades
Great Square of Pegasus
Markab
PISCES
30th
Menkar
Alrescha
Circlet
Celestial Equator
Mirror of Venus
Mira
CETUS
2nd
Neptune
Saturn
Steering Wheel
Enif
M15
EQUULEUS
ORION
M42
Rigel
ERIDANUS
M2
AQUARIUS
NGC 253
NGC 288
Deneb Kaitos
Fomalhaut
NGC 7293
27th
LEPUS
NGC 1317
NGC 1365
FORNAX
NGC 1316
NGC 300
SCULPTOR
NGC 55
COLUMBA
CAELUM
HOROLOGIUM
NGC 1433
NGC 7009
PISCIS AUSTRINUS
CAPRICORNUS
DORADO
RETICULUM
PHOENIX
Achernar
Canopus
PICTOR
LMC
Tarantula Nebula
NGC 362
GRUS
CARINA
VOLANS
MENSA
HYDRUS
SMC
47 Tucanae
TUCANA
INDUS
South Celestial Pole
M55
SAGITTARIUS
CHAMAELEON
OCTANS
PAVO
NGC 6752
Gem Cluster
Eta Carina Nebula
APUS
Running Chicken
MUSCA
TRIANGULUM AUSTRALE
TELESCOPIUM
CORONA AUSTRALIS
Acrux
Coal Sack
Jewel Box
CRUX
Rigel Kent
CIRCINUS
ARA
CENTAURUS